Bond University

DOCTORAL THESIS

E-Ludic Learning for Low ICT-Aware Areas :an Experiment in Tepeaca, Puebla, Mexico.

Dominguez, Luis

Award date:
2010

e-Ludic Learning for Low ICT-Aware Areas:

An Experiment in Tepeaca, Puebla, Mexico

by

Luis Carlos Dominguez

Submitted in total fulfilment of the requirements of the

degree of Doctor of Philosophy

Bond University

School of Humanities and Social Sciences

Gold Coast, Queensland, Australia

April, 2010

ABSTRACT

Knowledge is a pre-requisite for success in the Information Age. Societies that wish to achieve better economic outcomes for their populations need to provide better education first and foremost. Developed countries are investing in innovative methodologies and technologies to educate their populations, with positive results. However, while the acceptability and accessibility of Information Communication Technology in wealthy societies has aided its widespread adoption by the educational sector, low ICT-aware regions and nations are lagging behind in the educational digital divide. Correspondingly, while researchers in the developed world have focused on the benefits of incorporating engaging forms of ICT (such as games) into education, comparatively little research has been done on the impact of ICT in no-access regions.

This thesis is an attempt to fill that research void. It does so by proposing an engaging ICT model that was developed for, and tested in, a low-access region of Mexico. Fundamental to this model is the concept of e-Ludic learning, which seeks to deliver knowledge through the playful, engaging, and interactive environment characteristic of online gaming. The thesis experiment involved exposing primary students from the Juan Escutia Primary School in the regional town of Tepeaca, Mexico, to the e-Ludic learning program developed by the author. The experiment results answer the following research questions:

- Is e-Ludic learning an effective alternative educational tool?
- Does e-Ludic learning effectively increase ICT-awareness in low-technology environments?

The experiment results, processed using the data-analysis techniques of Analysis of covariance (ANCOVA) and effect sizes, confirmed that e-Ludic learning does represent an effective alternative educational tool and that it can be seen to effectively increase ICT-awareness in regions characterised by low levels of technology access.

The thesis also addresses e-Ludic learning's potential as an enabler of technological leapfrogs, whereby underdeveloped regions can bypass the industrial stage of economic development, with its associated costs and impracticalities, to become digital economic zones.

Thesis Chapters

Chapter One defines learning as a communicative process and acknowledges the importance of knowledge and ICT both to the transformation of learning and to development in contemporary economies. Chapter Two outlines the concept of play encompassed in ludic approaches to learning, and introduces e-Ludic learning as powerful new educational tool that synthesises digital technology and ludic learning. Chapter Three charts the short history of this nascent learning approach and presents case studies of commercially-available e-Ludic software programs. Chapter Four addresses the plight of low ICT-aware areas and examines current international initiatives aimed at tackling the digital divide. The latter part of this chapter details the Digital Puebla initiative, its importance as a development tool for the Tepeaca region, and its diffusion through a theoretical framework. Chapter Five presents the methods and Chapter Six the results of the thesis experiment conducted with SICOM and Juan Escutia Primary School students in Tepeaca, Puebla, Mexico. The final chapter, Chapter Seven, discusses the research questions, answers, and implications.

DECLARATION

This thesis is submitted to Bond University in fulfilment of the requirements of Doctor of Philosophy. I, Luis Carlos Dominguez, acknowledge that this research thesis, completed under the supervision of Dr. Jeffrey Brand, represents my own original work towards this research degree and contains no material which has been previously submitted for a degree or diploma at this University or any other institution, except where due acknowledgement is made.

Signature

Date 04/08/2009

The undersigned examiners certify that they have read this research thesis entitled

e-Ludic Learning for Low ICT-Aware Areas:

An Experiment in Tepeaca, Puebla, Mexico

Submitted by

Luis Carlos Dominguez

and recommend its acceptance in fulfilment of the requirements for the

Degree of Doctor of Philosophy

Signature of Examiner Date___________________________

Signature of Examiner Date___________________________

ACKNOWLEDGEMENTS

I wish to express my deepest and most sincere gratitude to my Thesis Supervisor, Dr. Jeff Brand. His guidance, time, and profound patience, have been greatly appreciated. His knowledge and conceptualisation have been fundamental to the elaboration of this research.

I am particularly thankful to the Consejo Nacional de Ciencia y Tecnologia (CONACYT) for supporting me financially. I am also indebted to Sistema de Información y Comunicación del Estado de Puebla (SICOM) and Digital Puebla team for all their support and their generosity in sharing of information; Yunuen Manjarrez, Raul Miranda, and Fernando Manzanilla, especially.

To my wife Marcela Sosa and to my daughter Maria Fernanda who have been there to encourage me: We and God only know how many obstacles we have had to face to achieve this dream.

I would like to thank my mother Maria Ortega, and my siblings: Eduardo, Alberto, Rebeca, Antonio and Masa Ono. I would also like to thank my father Luis Dominguez and all my uncles: Ramon, Eduardo, Tita, Maharshi, Femito (RIP), and so on, for giving me so much faith. I am indebted to Pastor Tabaquero for teaching me the ways of the Lord and to have faith in Him.

To my editors Ziyad Springborg, Chris and Nicky Lambert; I can’t thank you enough for your great English!

Last but not least, special thanks go to Bond University Faculty of Humanities and Social Sciences staff.

TABLE OF CONTENTS

TABLE OF CONTENTS FOR FIGURES AND TABLES

Figures

Tables

DEFINITION OF TERMS

e-Ludic learning: Learning that takes place in an electronic and playful environment involving the delivery of a body of knowledge through electronic channels such as CD-ROM, Internet, and Intranet. E-Ludic learning is the convergence of play theory and electronic learning. E-Ludic learning is learning-theory neutral.

ICT: Forms of technology that are used to create, store, share, transmit, or exchange information. This broad definition of ICT includes technologies such as telephone, radio, television, video, DVD, satellite systems, computer, and network hardware and software. It also encompasses the equipment and services associated with these technologies, such as video conferencing and electronic mail (Roongta & Priyadarshini, 2007, p. 1).

No-access region/area: Regions and areas that have little access to ICT.

Alternative educational tool: Educational techniques and technologies that diverge from those found in conventional education.

Digital divide: The gap between communities with regular and effective access to ICT and those without this access. It refers to both the physical accessibility of this technology and competency in its use.

ICT-aware: A conscious competency in relation to information and communication technology. It involves the accessibility, the knowledge, and the practical use of this technology.

Digital literacy: The convergence of computer and web literacy. Computer literacy refers to those terms and procedures required in the use of computers (Mayo, 2004). Web literacy refers to the degree of fluency in an online environment using a browser interface.

Low-technology environment: An Evironment that utilises manual and rural technologies and is characterised by an absence of information and communication technology. International organisations like the United Nations Educational, Scientific and Cultural Organisation (UNESCO) support the development of low-technology environments, as these are seen to underpin human and social development at the most basic level.

Digital puebla: The Mexican state of Puebla's e-government initiative to provide ICT in the form of public computers and Internet access to the inhabitants of the State of Puebla.

Content assimilation: The process of knowledge acquisition through a channel. For the purpose of this thesis, the channel is the Internet via an e-Ludic environment.

Targeted population: A set of inhabitants in a geographical area. A targeted population is a demographic group chosen for a particular goal. In this thesis, Juan Escutia Primary School of Tepeaca, in the State of Puebla, Mexico, was the targeted population chosen to answer the research questions.

CHAPTER I: LEARNING AS COMMUNICATION

1.1 OUR NEW WORLD

The term New World is not only an apt American cliché, it is also apt as a description of the Information Age. The Information Age, which began in the 21^{st} century, is the most rapid revolution ever experienced by humankind. The way we communicate, work, and learn is constantly changing. We are living in a digital world where progress and evolution are taking place at amazing speeds (Negroponte, 1996). Knowledge is the driving force behind this so-called Digital Revolution. Knowledge is the capital of this new world.

Parallel to the Digital Revolution, another revolution is unfolding; the Learning Revolution (Vos & Dryden, 2002). The Learning Revolution is being driven by discoveries in how we think, the different ways in which we learn, and how the human brain works (Rose, 1985). Discoveries in learning theory have been facilitated by the Digital Revolution. The intersection of these two revolutions is knowledge. This research does not debate which revolution arrived first. Rather, it focuses on how these two revolutions can be seen to complement each other.

The Digital Revolution involves the advancement of Information and Communication Technology (ICT). The Learning Revolution refers to the emergence of new ways for humans to transmit knowledge. Given that knowledge plays a central role in both revolutions, it is vitally important to discuss its role in our new world.

1.2 Knowledge as the New Competitive Advantage

Knowledge has been fundamental to humankind's ascent. Knowledge was required to make the first spear, and the first microchip. What has changed in the interval between the invention of the spear, the invention of the microchip, and today, is the quantity, quality, and density of knowledge and information, and the speed at which it circulates and changes (Hilbert, 2001, p. 13). Knowledge is the interpretation of information; it is the understanding of data obtained by any investigative method. Knowledge is what we learn and therefore learning is the process of knowledge assimilation.

A company can achieve better results in both production and client satisfaction by implementing proper knowledge management systems throughout its organisation (Driscoll, 2003). The same principle applies to the nation state. We can now access information more easily and cheaply than ever before. The amount of data that must be processed increases directly with the speed of information delivered. As a result, it is longer sufficient simply to possess information. How to most effectively utilise or deploy this information, itself now requires a great deal of creativity and knowledge.

Florida (2002) argues that creativity is the engine of the knowledge economy. He argues that the digital economy uses creativity as a new source of competitiveness. The emergence of creativity and knowledge production as vital tools for economic success is also discussed by McInerney and White (2000). They argue that the diminishing cost of information is an opportunity to generate wealth and, consequently, economic supremacy. When the cost of information falls, it is substituted with other costs, such as labour. This substitution pushes the prices of goods and services down, thereby empowering and enriching the consumer. Unsurprisingly, the consumer will try to maintain this status quo, by obtaining products that continue to keep the cost of information down. Such products facilitate communication between members of the socio-economic and political structure. McInerney and White (2000) use the computer as an example; once computers became a medium of communication with the advent of the Internet, their sales grew at a phenomenal rate. Companies and governments that understand this shift in power from the producer to the consumer, and adapt accordingly, stand to benefit from the surplus money produced by the substitution process of information costs.

The impetus behind the development of products that diminish information costs is creativity. Considering the shift of power from producer to consumer that has already taken place, the invention of new communication technologies should continue to favour consumer control. These technological innovations are the fruits of creative thinking. Beyond the creativity of the technology itself, however, the strategies and policies that companies and governments develop to enable a consumer-controlled environment, will themselves have to be flexible and creative.

The result has been, and will continue to be, the emergence of a creativity-based economy. Buderi (2000) explains how multinational corporations such as IBM, Microsoft, GE, and Xerox, have set up their own research labs (creativity being a fundamental element of research) which are now key to their economic success and survival. Knowledge acquisition and generation are not only determining factors in a product's value, they also enable the lower costs that come to be reflected in a product's market price. Progress fuelled by knowledge therefore acts as the engine of the Digital and Learning Revolutions.

1.3 THE DIGITAL REVOLUTION

As we have seen, the Digital Revolution involves the development of more efficient and accessible Information and Communication Technology (ICT), thereby facilitating the ever-more effective exchange of information between individuals, groups, societies, and industries.

1.4 Information and Communication Technology

Formulating an exact definition of ICT can be a complicated task given that new systems and products are added almost daily. For this reason it is better if we first differentiate ICT from other mass technologies.

The Human Communication Theory perspective provides three characteristics that clearly explain the difference between ICT and other mass communication technologies:

- ICT enables interactivity, permitting users or audiences to input communication into the medium which, in turn, responds to that input.

- ICT is a many-to-many message exchange (demassified). By contrast, mass media is a one-to-many message disseminated to a large collective grouping (massified).
- ICT is asynchronous, meaning that a message can be sent or received through ICT anytime the user desires. Mass media must be immediate or distributed using schedules (McQuail, 2005).

One of the main differences between ICT and traditional media, then, is interactivity. It is the possibility of interacting with a medium that turns a passive user into an active one. In education, the corollary is constructivist or constructionist learning methods as opposed to intructionist methods. In media terms, constructivist learning might involve a computer game, while instructionist learning might involve television.

It can be challenging to understand the concept of interactivity without first comprehending the different concepts that govern it, such as virtual reality and telepresence. Virtual Reality, as defined by Steuer (1995), is a real or simulated environment in which the person involved experiences teleprescence. Telepresence is described as a feeling of being in a particular atmosphere or environment through a communication system. Telepresence has two variables: vividness and interactivity. Vividness relates to the form in which the environment shows the information to a sensory channel. It has two attributes: breadth and depth. Breadth refers to the number of sensory channels activated when stimuli are simultaneously presented. Depth refers to the quality within each of these channels.

Interactivity is the degree to which users can be involved in shaping the content and structure of a mediated atmosphere in present mode. It is integrated by:

- Speed: the rate at which information is inputed into the mediated environment.
- Range: the amount of possible changes in action at any given time.
- Mapping: the transfer of the system controls into the mediated environment in a natural and predictable manner (Steuer, 1995, p.15).

Rafaeli (1988) defines interactivity as “an expression of the extent that in a given series of communication exchanges, any third (or later) transmission (or message) is related to the degree to which previous exchanges referred to even earlier transmissions” (p. 111). This more human-centric definition stands in contrast to Steuer’s more computer-centric definition. Rafaeli (1988, p. 119) identifies three levels of communication:

- two-way (no interactive) communication
- reactive (or quasi-interactive) communication
- fully interactive communication

According to this model, the degree of interactivity increases as the response, reference, and relation to previous messages increase. In relation to computer-mediated communication, Rafaeli would argue that video games are more interactive than soap operas, for example, because the game player’s actions are a direct response to previous messages posed by the machine. By contrast, actors in a soap opera do not perceive the viewer’s response.

Multimedia is a contemporary example of an interactive technology. It is defined “as a number of diverse technologies that allow visual and audio media to be taken and combined in new ways for the purpose of communicating” (Scala broadcast multimedia, p.23). It is also an interactive system and a form of Computer Mediated Communication (CMC).

1.4.i The Internet

The Internet is intrinsic to the Digital Revolution, permeating as it does just about every aspect of modern experience. Perhaps the Internet's most important feature is the ability it gives the user to interact with both content and other users. This has meant a shift in control from the sender to the receiver and the establishment of new online communities (Jones, 1999). This creation of an interactive *cyberspace* is no doubt central to the Internet's ubiquitous appeal. As Hilbert puts it: "Like every other communication technology, the Inernet is penetrating every aspect of life. Furthermore, due to its generic character, the Internet converged and integrated many other features leading to the creation of a special 'space', where people can go meet and communicate. This space is known as cyber-space" (Hilbert, 2001, p. 13).

Ferguson and Pierce (2000) explain that the exponential growth in Internet hosts and personal computer adoption has led to dramatic increases in online activity. They write that "a Commerce Net/Nielsen Media research survey (Commerce Net, 1998) estimated that 79 million Americans were online in June 1998 (with 68 million using the World Wide Web (WWW)). The same study estimates the number will continue to increase to about 126 million WWW users by 2000" (Ferguson & Pierce, 2000, p. 156). They suggest that while these numbers are still below those of the total U.S. television audience, the trend is that of the Internet rapidly becoming the dominant mass medium.

Today the Internet enjoys almost seventy-five percent penetration of the total North American population. Astonishingly, there has been a three-hundred-and-forty-two percent worldwide increase in Internet penetration from 2000 to 2008 (Internet world stats, 2008).

However, the web is more than a mass medium; it is also a community forum where users interact online. A community in the traditional sense is a group of individuals, male and/or female, who get together to interact and who are able to identify with one another. Such communities mediate between individuals and the social structure, providing a sense of belonging through congeniality. Congeniality occurs in the same geographical and temporal framework. Online communities are different, however. The process of communication among their members is called Computer Mediated Communication (CMC).

CMC, as Ferris (1997, para. 2) explains, refers to both task-related and interpersonal communication conducted by the computer. This includes communication both to and through a personal or mainframe computer and is generally understood to include:

- Asynchronous communication via email or through the use of an electronic bulletin board.
- Synchronous communication such as ‘chatting’ or through the use of group software.
- Information manipulation, retrieval and storage through computers and databases.

In this new community, people interact according to the identification of common interests (movie plots, soap operas, etc.). In online communities, the way people relate and the time these relationships last, differ from their offline counterparts. In cyberspace the interactivity, authenticity, and durability of relations can be ephemeral (Jones, 1999).

However, these aspects of online environments may be less important than the purpose of being online. For example, the Internet has provided a tool for online gaming and the development of online communities of players. The advantage of playing games on the Web is that it enables the user to play as long as there is an Internet connection. Not only can people play these games whenever they feel like, they can play with others who are not in the same room and may not even be in the same time zone. Many online games are free, and due to their considerable appeal, the Internet contains an enormous number of gaming-dedicated sites (Ward-Crixell, 2009).

The power of the Internet goes further than online communities and games, however. In cyberspace, data exchange occurs 24 hours a day, worldwide. People living in India can receive instant information from a research team in the USA, for example. The Internet works with digitalised data. Anything that can be expressed as a sequence of ones and zeros is digitalisable (a bit, as the smallest indivisible unit, is either 1 or 0). This can be letters, a movie, anything at all. Due to the ever-expanding capacity of bandwidth, data transmission and diffusion have grown exponentially in recent years (Hilbert, 2001, p. 15).

This process of worldwide data-sharing directly affects the way knowledge is disseminated, not only as it relates to individuals, but as it relates to companies and nations as well. A new economic system, e-commerce, has emerged. E-commerce can be seen not only to shape the way business is conducted online, it is fundamentally reshaping the way business is conducted full-stop. According to Hilbert (2001), e-commerce is one of the four layers of Internet economics:

- Layer One: refers to the base elements that constitute the Internet infrastructure. Examples are Internet Service Providers, networking companies, and so on.
- Layer Two: involves the software in which Internet applications are built in, such as Flash Macromedia or Java from Sun Microsystems.
- Layer Three: encompasses those companies that act as intermediaries in the process of online shopping, such as Yahoo or MSN.
- Layer Four, or the Internet Commerce Layer: refers to the final stage of the e-commerce process where companies and consumers, or companies and companies, directly see and buy their products online. Examples include Cisco, Dell, and IBM.

Internet economics is the driving force behind the Digital Revolution. The Internet represents the instantaneous exchange and share of data anywhere, anytime at low cost. The cost-benefit of instantaneous data-sharing is the key link between the Digital Revolution and economic benefits.

1.5 Benefits and Risks of the Digital Revolution

Most of the benefits of the Digital Revolution are realised when personal computers are turned into communications media instead of data-processing devices (McInerney & White, 2000). The Internet not only connects people with other people, it connects computers with other computers, and computers with people. As touched on earlier, these connections have brought many benefits to the economic and social structures of society.

1.5.i Lower Costs

Here I will use a personal experience to demonstrate the practical effect of lower costs resulting from the Digital Revolution. I have temporary residence in Australia while my permanent residence remains in Mexico City. I communicate monthly with my sponsor by sending reports in relation to my thesis. These reports are sent via email. The exchange of information is instantaneous and the cost is the one I pay to my Internet Service Provider (Layer One) per month, which comes to 30 U.S. dollars. If there was no Internet, and I was forced to use the fastest courier service between Australia to Mexico, at current rates I would have to pay between \$60 and \$70 USD per week, almost eight times the cost of the Internet. The spare money gained through the use of email is the cost of opportunity provided by the Internet. This money could be saved, or spent on other products and services, thereby injecting more money into the economy. If more international students in a similar situation to mine had Internet access, they would likewise be able to save and to thereby increase their purchasing power.

The same principle applies to Internet banking. For instance, I carry out all my payments through the online site of my bank, Westpac Corp. Instead of queuing at the local post office to pay electricity or telephone bills, I simply use the Bpay service which is accessed by logging onto the Westpac site. Once again, I save money by only paying the $30USD charged to my ISP, instead of the far greater expenditure in time and money involved in a physical visit to the post office or bank.

The benefits of the Digital Revolution are not only limited to the Internet. In some cases they also extend to people who do not enjoy direct Internet access. For example, international telephone cards in Australia (such as Chi-tel or Go-Bananas) provide very cheap rates for international, interstate, or mobile telephone calls. Table 1 provides a cost comparison between a mainstream Australian telephone carrier and an international telephone card:

Table 1. Telephone cards' international rates

Country	Home/Business Telephone Rate/min	Telephone CardRate/min	Savings
UK	38 cents	2 cents	95%
USA	31 cents	2 cents	94%
India	235 cents	35 cents	85%
Australia	23 cents	5 cents	78%

Note (telephone card selector)

While table 1 illustrates a selective case, similar discrepancies in cost can be seen to apply in relation to almost all big telecommunications companies worldwide.

1.5.ii Instant Data Exchange and Delivery

As we have seen, the Internet allows for the instantaneous exchange of information between parties. The Internet, coupled with internal networks of high-capacity computers, or intranets, can interconnect an entire organisation, enabling just-in-time high-speed internal operations and knowledge exchange. This rapid exchange of information is a vital ingredient of business success. Today, having rapid access to the right data makes the difference, not only in terms of market share, but also in terms of profits. Those companies that value information and knowledge, and take advantage of new communication technologies such as the Internet, will be best placed to succeed in an increasingly competitive business world (Buderi, 2000). Telecommunications giants like Cisco Systems and British Telecom claim that switching to online systems have saved them millions of dollars through the reduction of error rates and transaction processing fees (Hilbert, 2001).

The high-speed exchange of information also allows for the possibility of better collaboration among people and countries around the world. Cairncross (1997) refers to fast data exchange as a channel for the proliferation of ideas, improved writing and reading, the redistribution of wages, the rebalance of political power, and for global peace: "People who live under dictatorial regimes will make contact more easily with the rest of the world and as global trade and foreign investment grow, people will communicate more freely and learn more about the ideas and aspirations of human beings in other part of the globe. The effect will be to increase understanding, foster tolerance, and ultimately promote worldwide peace" (Cairncross, 1997, p. 16). Cairncross's view has some idealistic elements, but recent events have proven her correct, most notably the elections in

Iran. There, opposition groups used social networking sites to denounce what they perceived to be fraud in the presidential election. This enabled them to express their ideas in an otherwise impossible situation (Rhoades, Fowler & Cummins, 2009). Nonetheless, it is important to acknowledge that the benefits of the Digital Revolution do not represent a blanket solution to every social, economic, or political problem. Digital technologies are tools, which, if used appropriately, can be very beneficial to the organisation or the individual.

Whether the Internet remains the impetus behind productivity growth will be a matter for economic historians to sort out some years from now. What we can observe is that ICT is influencing all variables of growth. We know that in the Knowledge Society, information, and therefore the creation of new knowledge, is seen as the crucial input factor. Due to the increased flow of information (interconnectivity), we can now obtain this input factor a lot more easily and cheaply. Diagrammatically, this would result in the push of the aggregate supply curve (an economy's productive potential) out to the right, in exactly the same way as every major technological innovation has done in the past. Assuming no change in aggregate demand, the equilibrium level of production (normally termed Q) would rise, and the real cost of production would fall (Hilbert, 2001, p. 99).

It should be noted that some authors acknowledge that the exponential growth of ICT carries certain risks: network security flaws, computer viruses, private information intrusion, undesirable and misleading content, identity theft, and as some health practitioners have suggested, obesity, lack of physical activity, and other related medical conditions (Rosney, 1995). In this thesis I address the use of ICT in a secure environment, with an emphasis on the correct use of personal computers and the Internet. Adequate ICT management reduces any possible risks. A risk-free environment facilitates the Digital Revolution, enabling the generation and expansion of knowledge. This new knowledge is transmitted via different learning methods that have evolved dramatically in recent times as a result of the Learning Revolution.

1.6 THE LEARNING REVOLUTION

The importance of learning as a process has been an area of research for years. The ultimate goal remains to discover the best ways to learn, so as to enable humankind to learn more effectively (Reigeluth, 1999). "A revolution is taking place in education, one that addresses philosophies on how to teach, the relationship between teacher and student, on the way the classroom is structured, and the nature of the curriculum. At the heart of this revolution is a powerful pedagogy, one that has been developing over the past century. It embraces social issues, the culture of the classroom, life-long learning concerns and, last but not least, technology" (Norman & Spoher, 1996, para. 1). There are three main theoretical perspectives that make up the Learning Revolution:

- Behaviourism: primarily concerned with objective, observable events (stimuli, responses, reinforces).
- Cognitivism: primarily concerned with mental processes such as thinking, problem-solving, perception, and decision-making.
- Constructivism and all its derivatives (Lefrancois, 1995).

Other modern theories, such as accelerated learning, have based some of their assumptions on the above group of theories.

1.7 Behaviourism

This learning theory emerged in the 1930s, based on Skinner's research first with animals and then with humans. Skinner (1938) concluded that a child has a relatively passive nature and is shaped by external factors, such as the environment, in the form of *operant conditioning*. He asserted that if the presence of an *operant behaviour* is reinforced by the inclusion of a supplementary stimulus, the *operant behaviour* is strengthened. This is the stimuli-response-reinforcement conceptualisation of learning (Figure 1). Reinforcement can be a reward or a positive commentary. According to Skinner, learning is therefore determined by reinforcement and punishment based on stimuli and responses.

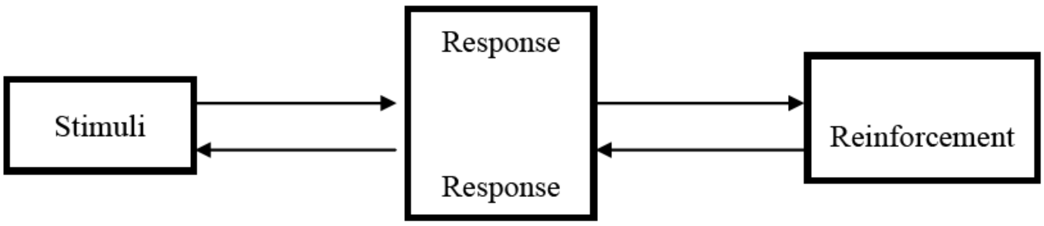


Figure 1. Stimuli reinforcement model (Skinner 1938)

Behavioural instruction involves the elaboration of objectives and provides the necessary path and strategies for the subject to reach these objectives. Assessment is based on the fulfilment of these objectives (Braden, 1996). Chen (2007) goes further by suggesting that multiple types of instructional goals and different strategies are required in order to achieve learning. Behavioural instruction involves:

- Drill and practice environments, such as laboratories for language instruction or some edutainment products.
- The teaching of psychomotor activities like driving, typing, or playing musical instruments.
- The creation of mathematical formulas or models for quantitative descriptions.

1.7.i Derived Perspectives

Different perspectives have emerged from within behaviourism, such as objectivism, social learning theory, and instructionism. Objectivism relates to the idea of an objective reality that goes beyond the learner (Duffy & Jonnassen, 1991). Mathematical instruction, which is considered objective and universal, falls into this type of conception. In objectivism, knowledge is seen as independent from the learner experience (Phillips, 1998). Social learning theory adds to behaviourism the notion of imitation as a form of learning. This theory indicates that children tend to select both whom to imitate and which behaviours to imitate (Bandura, 1977). Instructionism comes from a behavioural perspective. The learner is a passive recipient of information, with a teacher-centred approach.

A fundamental criticism of behaviourism is that by focusing solely on quantifiable and visible expressions of behaviour, it fails to acknowledge the existence of mental processes and cognition (Graham, 2007). It was only through the work of scientists such as Piaget that a new perspective emerged in the 1960s (Kail & Cavanaugh, 2004).

1.8. Cognitivism

Cognitivist learning theories relate to internal mental processes. The word cognition indicates a learning experience whereby knowledge is built up. From a cognitivist perspective, the mental methods employed in problem-solving are the fundamental means of learning. The focus is on what learners know and how they learned what they know rather than on their behavioural responses.

1.8.i Origins of Cognitivism

Cognitivist theories are deeply rooted in the work of the Swiss scientist Jean Piaget, whose research on human development dates back to the 1920s. Piaget concluded that children make sense of their world in a natural way. His main thesis is that a child builds his/her own understandings through a variety of channels such as reading, listening, exploring, and experiencing their own environment (Piaget, 1950). The intelligence of a child matures with the growth of their mental structure or *schemata*. This mental structure or *schemata* acts as a tool in the process of adaptation to the environment. From the first day of birth, all babies reflect their environment. The moment a specific stimulus is presented the infant reacts to it (Dacey & Travers, 1996). Child behaviour emulates that of a researcher who creates a hypothesis about a specific event or stimulus. Once the stimulus repeats, the child tests its validity by mentally comparing it to the previous case.

If the child's assumption is proved correct, then his/her belief in the hypothesis increases. When their expectations are not met, they revise their hypotheses accordingly. Piaget's (1950) ideas go further, by considering the existence of certain stages wherein the child reviews all of his/her assumptions in a radical way. These changes are schematised in Table 2.

Table 2. Piaget's stages of cognitive development

Estimated Age	**Stage**	**Main Developments**
Birth to two years	Sensory motor	Child's understanding of the world comes from sensory and motor skills. First mental schemas appear at the end of this stage.
two to seven years	Preoperational	Child commences to use symbols like words and numbers. They answer to objects and events based on how they appear to be in their own perspective.
seven to 11 years	Concrete operations	Child commences to think in a logical way by applying logical operations.
11 years and beyond	Formal operations	Child begins to think in an abstract manner. Thought is systematic and speculative in relation to possible outcomes.

Note (Piaget, 1950 and Kail & Cavanaugh, 2004)

In Piaget´s view, a child develops through each of these stages until they reach a level where they reason in a logical manner. The child progresses to each stage in a linear way and there is no regression among stages. Advancement through each stage is achieved by organisation and adaptation. Organisation happens in a natural way and enables the individual to organise their schemata more efficiently. Schemata are constantly reorganised, and as new schemata are acquired, they come to be integrated into pre-existing ones. Adaptation involves two complementary processes:

- Assimilation: in which new external experiences are integrated into existing schemata.
- Accommodation: whereby existing schemata are modified to accord with new external experiences (Dacey & Travers, 1996).

1.8.ii Derived Perspectives

Cognitivist theories focus on mental processes as the central factor in learning activity. Researchers like Newell and Simon (1972) postulate that the human brain resembles a computer and can be represented as an information processing system. According to this perspective, the mental hardware is memory, where information is stored. The mental software includes groups of cognitive processes that enable the achievement of specific tasks (Kail & Cavanaugh, 2004). Mental hardware and software get progressively better as the child grows older, until the point where deterioration sets in due to the ageing process (Kail & Cavanaugh, 2004).

Gagné and Glasser (1987) model proposed that human learning takes the form of an information-processing model. Information or input accesses the human brain through human receivers. Incoming information is momentarily stored in short-term memory. Short-term memory has a section for working memory where data is retrieved from long-term memory and then compared to the new information which has been allocated to primary memory on a temporary basis. This process of integration with existing knowledge takes place after the matching and pattern recognition process. Expansion of this model has influenced other fields. Research into human information processing has led to advancements in the field of artificial intelligence, for example (Kail & Cavanaugh, 2004).

1.8.iii Automaticity

Behaviourism and cognitivism can be found together in certain conditions. Automaticity, for example, contains both learning processes. Automaticity refers to the skill to perform an activity inadvertenly, accurately, and rapidly, while rationally performing other mental activities at the same time (Bloom, 1986). It involves practice and the related automatisation of this activity to the memory. As Logan and Etherton put it:

"Novice performance is based on some kind of algorithmic computation. With practice, over the course of automatisation, the algorithm drops out and memory retrieval takes over. Automatisation is a transition from algorithm-based performance to memory based-performance" (Logan & Etherton, 1999, p. 166).

Constant practice and training produces the automaticity of the specific sub-skills needed to perform better. Once automaticity is achieved, these sub-skills occur without dedicated awareness, as in the case of arithmetical reasoning. Maintaining automaticity requires constant use rather than any special type of practice (Bloom, 1986).

Logan and Etherton (1999) indicate that "constant training under consistent mapping produces the changes associated with automatisation: a reduction in reaction time, a reduction in load effects and a reduction in dual-task interference" (p. 169). Consistent mapping is achieved by keeping the target categories intact throughout the training process (Logan & Etherton, 1999). During automatisation new knowledge is acquired through controlled processing. Controlled processing overloads the working memory through a process of cognitive loading, thereby leaving no space for higher order learning activities (Schneider & Chein, 2003). *Overlearning*, by means of constant mapping, training, and practice, then permits the transfer of the acquired knowledge from the working, short-term memory to long-term memory (Figure 2), and its rapid and efficient retrieval when needed (Samuels & Flor, 1997).

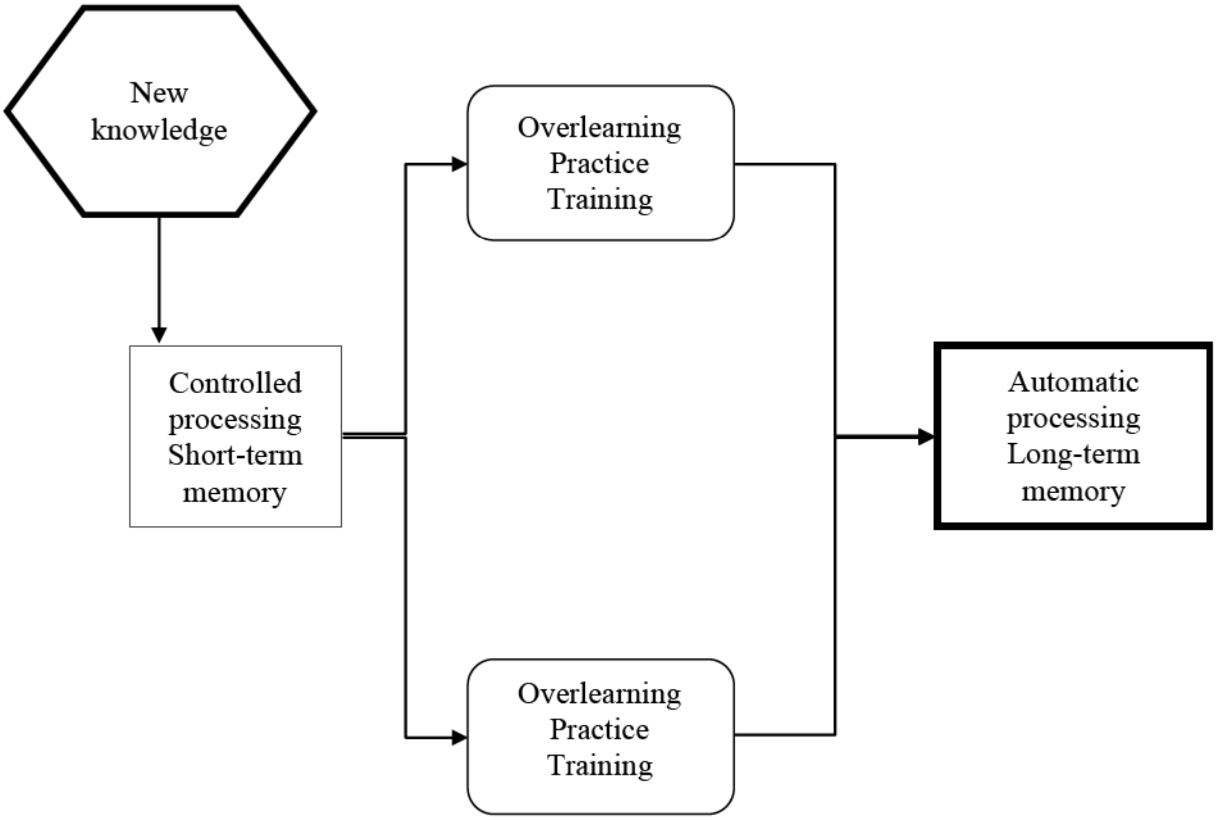


Figure 2. Automaticity model

There is no new knowledge in automatic processing; all new knowledge comes through controlled processing. Automaticity creates expertise through practice and is evident in sports, and in manual activities such as riding a bicycle, or learning how to drive a car. Automaticity also suits basic arithmetic instruction. Research indicates that automaticity in basic arithmetic operations, such as adding and subtracting, is highly desirable in order to achieve better results at more advanced levels such as algebra (Tournaki, 2003).

I selected automaticity as the learning theory to embed in the e-Ludic learning environment, because addition was the subject that needed to be delivered through this environment. Basic numerical addition was selected because this was the content that the people from Digital Puebla deemed as being of highest priority. However, the e-Ludic model can involve any learning theory depending on the nature of the content and the nature of the learner. E-ludic learning is learning theory neutral and depends on the user's learning style.

In the specific case of cognitivism, it is important to acknowledge the fact that it provides a deep understanding of how humans learn and the internal process that take place inside the brain. Cognitivistic instruction and learning design must consider:

- That the learner brings different previously learned experiences that may affect the outcome of the new learning situation.
- What is the best way to organise and structure new knowledge so as to tap into the learner's prior knowledge?
- Providing learning feedback so the learner can accommodate new knowledge within their prior mental structure.

Cognitivistic thinking expanded in the 1960s with the emergence of a new learning theory, constructivism, again based on Piaget´s research results. Constructivism places greater emphasis on the subjective nature of the learning process, and acknowledges some of Piaget's critics in relation to the lack of consideration given to those cognitive tools inherited from our cultural past and our social setting (Egan, 1997).

1.9 Constructivism

Parallel to the evolution of digital technologies, the realm of education has suffered a change in understanding about the fundamentals of human learning and the environment that fosters it. According to Applefield, Huber and Moallen (2001), constructivism represents this paradigm shift. Behaviourism and cognitivism are linked to objectivist philosophy, while the constructivism that Applefield, Huber and Moallen describe proposes that learners gain their understanding from the process of a *meaning-making* search, whereby these learners construct an interpretation of their own experiences. The results that emerge from the review, analysys and testing of experiences and tasks, will produce knowledge that has limited association to external reality. Nonetheless, the fact that learning generally flows from a process of social negotiation means that shared meanings will tend to be constructed. Constructivism emphasises knowledge construction, instead of the transmission of knowledge and information recording by others (Fosnot, 1996). The process of knowledge construction involves different perspectives. Moshman (1982) refers to three types of constructivism:

- Exogenous constructivism: The learner's mental schema organises in such a way as to reconstruct an external reality. Knowledge is constructed as a reflection of the outside world.

- Endogenous or cognitive constructivism: The learner constructs knowledge individually and internally through a process of negotiating external experiences that differ from their current mental organisation. New experiences or knowledge produce disequilibrium when they fail to match the present conceptions of the individual. This results in the modification and advancement of their mental organisation through revision, and the creation of new cognitive structures out of pre-existing ones.

- Dialectical or social constructivism: Considers the construction of knowledge as an outcome of social interaction and the sharing of different meanings among individuals. This process of social interaction involves cognitive give-and-take whereby the individual constructs knowledge. It stands in contrast to cognitive constructivism in which an individual's investigation is the source of learning (Figure 3).

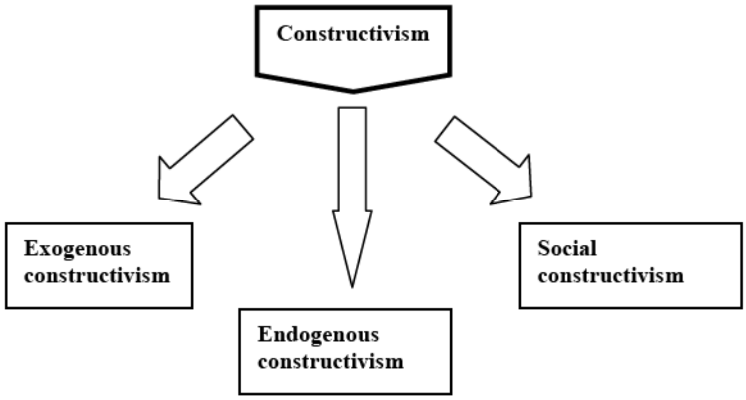


Figure 3. Perspectives of constructivism (Moshman, 1982)

The process of social constructivism involves additional concepts such as situated cognition, zone of proximal development, cognitive apprenticeship, and generative learning.

Situated cognition is tied to social constructivist approaches. In situated cognition, knowledge is viewed as a piece of the puzzle where learning occurs. Consequently, it places fundamental importance on context; the social and cultural environment from which the learning process is considered to originate. In situated cognition, the knowledge we construct is directly linked to the social and physical space in which learning takes place. A key element of situated cognition is cooperative learning, in which cognition is regarded as an inclusive process. Cooperative learning is a discovery-oriented instructional approach that assumes the social nature of learning. A constructivist perspective utilises cooperative learning assignments and supportive tutoring, in the belief that students will learn more by engaging in a dialogue with one another.

The zone of proximal development (Vygotsky, 1978) is the space wherein a learner works on assignments that can only be finalised and concluded with the support of a person qualified for the task. In this case they are considered to be collaborating within their nearest development space. Cognitive apprenticeship suggests that one learns on-site by observing and working with an expert.

Generative learning proposes that all learning is discovered. Its main thesis is that to assimilate recent meanings from the person's social setting, and to become a builder of meanings, requires the use of very concrete intellectual capabilities, whether specifically taught to leaners or discovered by them (Applefield, Huber & Moallen, 2001).

In short, constructivism represents a shift in the view of teaching, from a teacher-centred perspective to a student-centred perspective. It thereby places the learner as the leading actor in the educational system. Proponents of constructivist thinking argue that learners construct their own learning, that this learning depends to a very real degree on existing understandings, that social interaction performs a critical role, and that meaningful learning requires authentic learning tasks.

In the past two decades, researchers at the Massachusetts Institute of Technology (MIT) Media Lab and the Epistemology and Learning Group have further advanced constructivist ideas. They have developed a deeper concept, constructionism.
Seymour Papert (1981), the man behind constructionism learning theory, describes this learning method by emphasising that constructionism is much more than *learning by making*. For Papert, "Constructionism shares the constructivist's (Piaget) connotation of learning as building knowledge structures irrespective of the circumstances of the learning. It then adds the idea that this happens especially felicitously in a context where the learner

is consciously engaged in constructing a public entity, whether it's a sand castle on the beach or a theory of the universe" (Papert & Harel, 1991, p.12).

This public entity, sometimes called the learning environment or micro world, is a small and complete version of any given system, such as, for example, a sandcastle or the program LOGO (Papert, 1981). Moreover, Papert acknowledges the constructionism versus instructionism paradigm: "traditional epistemology gives a privileged position to knowledge that is abstract, impersonal and detached from the knower and treats other forms of knowledge as inferior. But feminist scholars have argued that many women prefer working with more personal, less-detached knowledge and do so very successfully" (Papert & Harel, 1991, p. 25). Papert concludes that if it holds true that more personal, less-detached knowledge can be equally effective, the learner should opt for the more tangible objects of knowledge (inductive thinking) preferred by constructionism, to the abstract structures of knowledge (deductive thinking) preferred by instructionism.

Constructionism itself has gone further by incorporating new notions and descriptions. One such development is distributed constructionism, a term coined by Michael Resnick, which is rooted in the ideas of constructionism and distributed cognition. Resnick (1996) explains that constructionism is supported by two modes of constructions.

First, he argues that learning is a process in which people purposely and conciously build knowledge out of their personal view of the world surrounding them. According to Resnick, someone does not *get* knowledge, they *make* it. Thus, constructionism includes the view that people construct new understandings more accurately when engaged in activities they find significant or constructive (e.g., building a sand castle or using LEGO bricks). The attention of students has proved to be sustained for one hour more per day over an extended period of months when making, contrary to just using, software content. Moreover, it has been reported that the constructionist activity of making the software also improves the teacher's instruction about that software content (Papert & Harel, 1991). Students who have previously been exposed to some mathematical concepts in the traditional analysis-centred approach, but proved to be poor learners, have shown improvements in their understanding after using LEGO brick building activities involving constructionist concepts (Resnick & Ocko, 1991).

Second, distributed cognition refers to the fact that cognition and intelligence are not the properties of an individual person, but stem from the interactions of the individual with their environment (including other people and artefacts). However, according to sociocultural construnctionist thinking, the process of creating knowledge communities varies depending on social setting and cultural background (Pinkett, 2000). Sociocultural Constructionism, as the name suggests, is a blend of social constructionist and cultural constructionist theories, both based on Papert's theory of constructionism (Pinkett, 2000). Constructionism suggests that learning is more efficient when there is design activities involved in the process. Distributed constructionism adds the ideas of sociocultural theorists such as Vygotsky (1978) to constructionism. Constructionists assert that a person learns through the construction and reconstruction of his or her perceptions and schemas in relation to a particular cultural and social setting. The construction of meaning is explained by the learner's cognitive structure. Sociocultural thinking asserts that the individual learns through their involvement in a particular social setting and cultural background. The construction of knowledge is therefore a process of socialisation and acculturation.

Distributed constructionism encompasses both cognitivist and sociocultural perspectives. A distributed constructionist learning environment pays particular attention to the development of the individual's cognitive structures, allowing them to explore their particular interest with the support of collaborative activities (Resnick, 1996). Social constructionism adds a social dimension to the collaborative activities Resnick refers to, while cultural constructionism regards the cultural setting as the common locus, or sharing point, in knowledge construction (Pinkett, 2000). Pinkett explains that:

> the theory of social constructionism states that individual developmental cycles are enhanced by shared constructive activity in the social setting and the social setting is also enhanced by the developmental activity of the individual…Cultural constructionism argues that individuals learn particularly well through creating objects in the world that express their cultural identity and have shared meaning within their home cultures (Pinkett, 2000, p. 4).

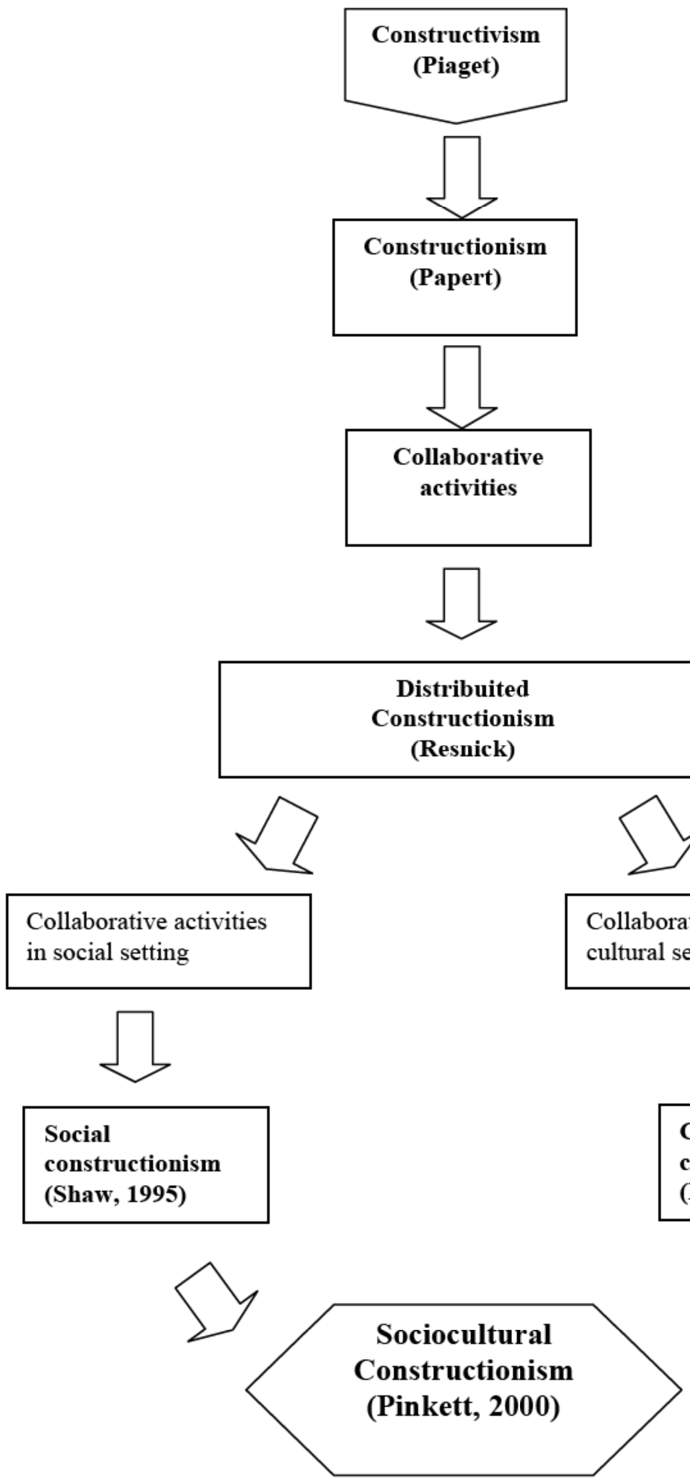


Figure 4. The path for social constructionism

The emergence of constructionism, as outlined above, has reintensified the debate between instructionist and constructivist camps. Instructionist methods of teaching and delivering knowledge are specific about what students are expected to learn. Instructionist learning environments employ what Prensky (2000) terms the *tell-test* system, in which testing provides a frequent source of feedback on progress; success is rewarded, failure is unacceptable, and the effort continues until specific goals are attained. The tutor's goal in instructionist learning is to transfer some relatively static components of information about the topic to the student. According to McArthur et al., "If we can analyse the knowledge we wish to transfer to the student into constituent parts, then the most efficient way to transfer this knowledge to students should be to carefully tutor it piece by piece" (McArthur, Lewis and Bishay, 1993, para. 6). From this perspective, learning is more about the content than the learner; the focus is on what is taught and not why or how (Finn & Ravitch, 1996).

The divergence, or tension, between instructionism and constructivism is explained by Katz, Earl and Olson (2001). They identify two very different domains in formal education:

- what is known collectively
- what is known subjectively

The authors name the former the *known* and the latter the *knower*. According to this paradigm, the known is formed by facts. A student commences his/her education with their brain as yet lacking the basic information, data and concepts that subsequently come to be transferred in a one-way direction from the trainer, document, or authority. Thus, teaching becomes just a telling process, and learning a remembering process.

However, the concept of what is known subjectively, the knower, stands in stark contrast to the known. From this point of view, the known is not an indisputable fact of nature. Given that knowledge originates from the individual's processing of personal cognition, it can be said to be made, not found, and therefore uncertain. Thus, reality varies from person to person and knowledge is interpreted subjectively. The final thesis of Katz et al. (2001) demonstrates how this tension between the known and the knower plays out in the practical arena of the classroom, where the teacher has to reconcile these antagonistic perspectives. The teacher is required to meet fixed and predetermined goals in the process of teaching independent individuals with multiple and divergent interests, aspirations, and origins. Katz et al. (2001) conclude that when the known is more important than the knower, the student is tested based on a norm or standard qualification, such as an exam. Conversely, when the knower is more important, the measure comes from a subjective procedure of interpretation.

The conflict between the known and the knower, between objective knowledge and constructed knowledge, and between instructionism and constructivism, are of course one and the same. However, there is as yet no clear research evidence to champion one methodology over the other (Miller, 1994; Johnson, 2005). Some students perform better using the inductive methodologies of creative thinking and active participation characteristic of contructivism and its offshoot, constructionism. Other students peform better using the deductive methodologies of abstract thinking and passive participation characteristic of Instructionism (Finn et al., 1996; Johnson, 2005). What is generally agreed upon is that instructionism better suits passive media such as television, while constructivism better suits active media such as video games (Diaz & Bontenbal, 2000).

In recent years researchers have concluded that in addition to a rational division of labour between the two methodologies (instructionism for objective knowledge, i.e., basic arithmetic or spelling content; constructivism for meaningful philosophies involving personal interpretation, i.e., sales or marketing content) (Johnson, 2005), a balance can and should be struck between these two ostensibly antagonist perspectives (Olufemi, 2008). While further research is needed to more fully understand the nature of human learning, some early research on accelerated learning provides perspective.

1.10 Accelerated Learning

Rose (1985) describes accelerated learning in the light of recent brain research. He argues that in traditional learning methodologies the means to success has been constant repetition. In accelerated learning, by contrast, the goal is to achieve a relaxed and pleasant mood. In so doing, the mind becomes receptive and information is presented in a way such that both the right and left sides of the brain actively participate. The basis of accelerated learning comes from neurological research. According to Rose, it has been found that the "fundamental determinant of the brain's potential is the number of connections it can make" (Rose, 1985, p. 9). He contends that: "the brain is the only organ that expands through use. The more it is used, either to acquire facts or in the process of creativity, the more memory associations are formed. The more associations that are formed, the easier is to remember previously acquired information and also to form new associations, new ideas or concepts. This is a virtual circle" (p. 10).

The brain has developed through natural evolution, and while it appears that we do not use its entire capacity, what is known for certain is that it is divided into two hemispheres connected by an extensive network of fibres called the corpus callosum. It has been found that each hemisphere has its own specialisation at a basic level. The right side processes some artistic and spatial patterns, as well as beauty and loyalty. The left side deals with basic language, mathematical processes, logical thought, sequences, and analysis. Both sides work with each other in order to reduce possible competition and excessive workload in relation to intellectual functioning (Saling, 2004).

Moreover, it is now believed that most learning involves an interaction between the two hemispheres of the brain. It appears that instinctual behaviour originating in the reptilian brain is transmitted to rational thought in the neocortex via the limbic system (Vos, 1999). Indeed many researchers currently believe that the clues to better learning may lie in the limbic system where emotions take place. They base this on the fact that an appeal to the emotions has been established as the best way to create memory and attention (Vos & Dryden, 2002).

There is no learning process without memory and psychologists agree that two types of memory exist; short-term and long-term. Short-term memory is the working memory and can be likened to RAM memory in a computer. By contrast, long-term memory is permanently stored and is comparable to a computer's hard drive. It appears that the short-term memory processes information while the long-term memory integrates information. According to Grieve, the memory process involves three different activities; registration, retention, and recall (Grieve, 2003). Registration, or encoding, is when a person consciously identifies new information and attempts to place it into their long-term memory. Retention is when this information is successfully stored in long-term memory. Recall is when a person is able to recall certain facts when required.

New information can only be placed into long-term memory from short-memory if it is exercised instantaneously. This new information relies on being properly encoded and encoding depends on significant associations. In turn, significant associations are achieved through the absolute and concrete images provided by the senses. The more significant the initial encoding, the more effective the ultimate recall, according to Grieve (2003). However, recall is easier than, and different to, recognition. Words associated with pictures are easier to learn and to remember. Recall relies on associations and organising concepts in common mental schemas (Vos, 1999). Visual memory is essentially a natural process of facilitating stronger associations. The key to achieving more efficient memory (and learning) is consequently to increase visualisation and to create meaningful visual associations for new material. Visual images that involve some degree of interaction are the most powerful.

It is worth noting here that association is a key concept in the development of the e-Ludic learning environment that forms the subject of this thesis. The science indicates that more time spent visualising, the better the learning outcomes will be. Interactive games may therefore prove to be powerful learning tools.

Baroque, and other classical musical forms, have been found to support learning processes. These types of music appear to connect the left and right sides of the brain to develop an association with the material's audio content and rhythm, and to thereby create a relaxing atmosphere (Malone, 2003). Similarly, it has been established that in some instances mental blocks can be overcome with positive suggestion that something can be achieved. When a positive or negative suggestion finds its way to the subconscious layer of the mind, the subconscious finds a way of retrieving it. Thus, subconscious thinking seems to be manipulated by the limbic system and is best penetrated and modified, not through logic, but by emotions.

Learning is most efficient when all the senses are focused in the learning process. Considering that almost all communication is on a subconscious level, the greater the number of subconscious stimuli activated to aid in learning, the faster and more productive the learning becomes. Moreover, learning styles can be seen to vary from person to person. Some learners have a visual learning style, while others have an auditory, or kinaesthetic, learning style. However, this does not mean that a person learns by using only one style. It simply means that if the material is presented in an individual's preferred learning style the process will be easier (Constantinidou & Baker, 2003).

Accelerated learning is therefore a technique that strives for associations and memory usage to achieve faster, more permanent, and better learning (Rose, 1985). However, there are critics of such brain-based techniques. In the main these contend that there is as yet insufficient evidence to confirm many of the brain-based learning fundamentals described above. For example, Jensen claims that "there is no evidence that having more synapses will make a student smarter" (Jensen, 2000, para.1). However, even Jensen acknowledges that scepticism should not stop us from taking advantage of some of the benefits of brain-based techniques, as in *Fast For Word*, a reading augmentation product developed using results derived from neuro-plasticity research (Jensen, 2000).

After reviewing the current learning theories it remains tempting to ask "which is the best learning methodology?" However, no conclusive evidence as yet exists to champion one particular methodology above all others. Rather, the current debate is reduced to two main models, associative learning and rule learning. The associative model relates to neural networks and pattern associations. The rule learning model has to do with symbol manipulation or computational learning. Association theories hypothesise that the learning process is a process of associating patterns between different stimuli, while symbolic manipulation considers that the learner learns abstract rules for patterns between different stimuli (Leslie, 2001).

When attempting to choose the best learning methodology, focus should be applied to the material's content and the learner's characteristics. The e-Ludic environment developed for this thesis achieves automaticity in the learner because the content is of the objective kind, namely, arithmetic instruction. Automaticity requires previous exposure to the learning material. Pattern association is delivered through the use of visual and auditory elements such as those used in accelerated learning contexts. Constructivism is used less in the thesis model due to the objective nature of the content. In addition, the thesis model considers emotional factors as a learning incentive. In the process of attempting to explain how the mind works and how we learn, behaviourism, cognitivism, and constructivism focus almost exclusively on the rational process, thereby omitting emotional factors.

1.11 Benefits of the Learning Revolution

1.11.i Student-Centred Approach

New learning theories have placed greater emphasis on student-centric approaches, in contrast to traditional teacher-centric approaches. In these theories the learner has greater freedom of thought and creation. The goal of education should be to teach people how to think, how to create, and how to understand the world around them. This does not mean that the teacher need become marginalised. Rather, it means that the teacher may come to be more accurately perceived as a learning facilitator.

1.11.ii Shift in Education

The Learning Revolution, a term coined by Jeannette Voss and Gordon Dryden (1999), involves a comprehensive shift in the way education and learning are conceived. The traditional school structure is changing and adapting to newly-available learning philosophies and technologies. In the current climate, wherein knowledge is a competitive advantage which is able to be delivered anywhere/anytime by the Internet, it should be a mandatory requirement of national education policy for governments worldwide to focus spending on both the implementation of these methodologies, and ongoing investment in these technologies.

1.11.iii Target Population

The Learning Revolution involves understanding new learning theories as well as life-long learning. It also suggests that there should be a greater focus on education during the formative years of a child's life. Babies' brains already have millions of neuronal connections from birth. In the first month of life, an infant's senses interact with the world to such an extent that their brains develop more neural connections at this time than at any other stage of life; almost 1,000 billion connections by the time they turn eight months old. However, these connections become obsolete in the absence of constant sensorial stimulation. By the age of eight the number of neuronal connections settles down to 500 billion. From the age of 12 on, the number of neuronal connections remain static (Vos & Dryden, 1999). Of course this does not mean that after 12 years of age people stop learning. Rather, it demonstrates that the mental structure for future learning is set within the first 12 years of life. As a result, many national educational policies currently address pre-primary and primary education in the hope that by establishing sensory stimulation in early childhood education, improved intellectual outcomes can be realised down the track.

1.12 THE SYNTHESIS OF THE DIGITAL AND LEARNING REVOLUTIONS

Knowledge is the common thread of the Digital and Learning revolutions. Moreover, knowledge acts as both the main input and output of these revolutions. Education-derived knowledge provides the input to these revolutions by acting as the generator of new information technology which, in turn, makes the transmission of information faster. Depending upon the interface, these new technologies can deliver information in alternate learning forms, thereby enabling the more efficient assimilation of this information by the learner. The delivered information is then transformed into knowledge. Some of this new knowledge will go on to become new inputs in the process of information technology development, and so the cycle contintues. Learning is the process and digital technology the delivery system. Both contribute to the Knowledge Cycle (Figure 5).

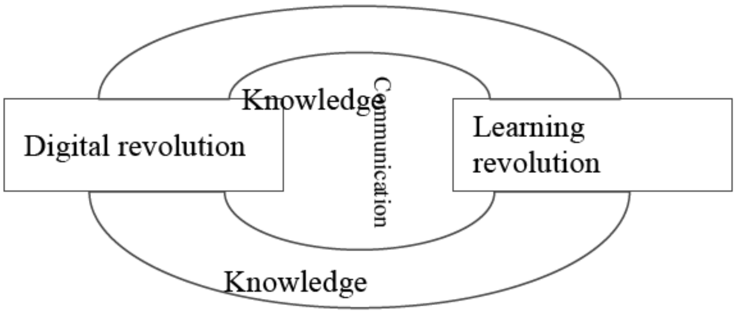


Figure 5. The knowledge cycle

The intersection of both revolutions is communication. Learning is a communicative process that involves the transmission and reception of ideas. Increasingly, this transmission requires the creation of content by a teacher for the reconstruction by a learner using interactive media such as computer games. Learning is therefore a communication process in which knowledge is the content and digital technology the channel.

1.13 Learning as Communication

Learning takes place within a communicative process. It involves a sender and a receiver, a message interpretation and a meaning negotiation (McQuail, 2005). Learning theories have found a place in the cognitive and behavioural genres of communication research (Littlejohn, 1992). Indeed, they now form part of the canon of psychology scholarship. Instructionist learning theories have adopted a transmission model of communication that sees the individual as a mere sender and recipient of information (Driscoll, 1994). By contrast, social learning theory and constructivist models highlight the importance of constructing meaning and the centrality of cultural context in the communicative process (Crawford, 1996).

In this thesis, learning is considered to be a communication process involving the process of knowledge acquisition by an individual. This is a transactional process where knowledge is both sent and received (Capurro, 2003). Education and knowledge transmission originally started as a communicative process passed on from generation to generation. Today, both remain as communicative processes. What has changed is the format in which they are now delivered. It is in relation to format that digitalisation plays its part.

Learning and communication media have always worked together, educational television being a prime example (Shalom, 2004). When the Internet emerged it was only a matter of time before both joined forces. We know this collaboration as e-learning, and it is a concept that is fundamental to this thesis. E-learning goes further than previous collaborations between learning and communication media, representing as it does the convergence of new media technologies, the Internet, and distance education (Bates, 2005). The OECD (2005) refers to e-learning as the use of ICT to enhance learning end education. E-learning is considered in this thesis as the digitalisation of learning.

Concepts such as interactivity and flow that belong to communication research are fundamental to understanding e-learning environments. Indeed, the understanding of interactivity from a communication perspective provides the necessary conceptual framework to develop an e-learning environment (Jensen, 1998; Klett, 2002). The communicative process in an e-learning environment takes place in a computer- mediated set. Computer-mediated communication is a new form of communication technology (Truss, 2003). As new technologies develop and diffuse, new forms of communication inevitably emerge. Moreover, experience teaches us that the younger generation who have grown up with this emergent technology go on to become its most savvy users. This is very much in evidence with the Internet boom, in which so-called Generation X members (and their successors, Generation Y) have proven to be the most enthusiastic and literate users of this technology (Oblinger, 2003).

1.14 Generation X Users

Generation X is a term coined in North America. Weston (2001) explains that three distinct generational cohorts exist in the contemporary American workforce, each sharing the same social space and time. These are: *Silents, Baby Boomers* and *Xs*. Weston (2001) characterises the silent generation as the most mature employees in the workforce. They were born in 1945 or earlier, and while they grew up in an industrial model of production, they were the first to experience the beginnings of the information age. Hence they have experienced the change from managing tools and machines, to managing knowledge and information. The Silents have traditional American beliefs and were educated in highly structured and regimented school systems with clear rules and guidelines.

According to Weston (2001), Baby Boomers encompass those born between 1945 and 1960. They are idealistic and expect to make the world a better place. They have learnt not to respect authority due to the civil rights movements, the Vietnam War, and the Watergate scandal. Baby Boomers have adapted technology to suit their needs and to enable them to have more free time. This is the questioning generation that challenges the status quo.

Generation X, sometimes called the Net Generation or the Video Game Generation, encompasses those born between 1960 and 1980 (DDN, 2005). This generation has been raised in relatively permissive homes where parents were absent (divorce, work commitments, etc.), thereby leaving them to their own devices (Reese, 1999). Playing video games is one of their chosen forms of entertainment. They have grown up with technology and are therefore more comfortable with it.

Playing video games, viewing MTV, and watching action movies may have equipped Xs with the necessary skills to better adapt to the frenetic, ever-evolving, and highly technical environment of the new, digitalised world. Here, the argument is not simply that Generation X is well suited to today's world in the superficial sense of being comfortable operating in this type of environment. Rather, it embraces the more profound notion that the environment of Generation X's youth produced a different cognitive structure to those of their parents and grandparents, and that this unique cognitive structure endows them an actual, quantifiable, physical/mental advantage. Due to their developing minds having been exposed to fast-paced environments through such media as computer games, music television, and action movies, some cognitive structures have been reinforced and others de-emphasised. Moreover, it is increasingly expected that educators, trainers and company managers be aware of this mindset in order to best relate to Generation X employees, and that they adapt working environments so as to get the most out of Generation X employees (Prensky, 1998).

As video games and other interactive media evolve, the concept of Generation X, although American in origin, is becoming universal, like a global cultural icon branding world digital generations. Video games are part of what have been called *cultural industries* (Hesmondhalgh, 2002), whose ideological penetration has no frontiers worldwide. This ideological penetration has a brain-shaping component that influences the user or game player. A common video game cultural affinity comes to be obtained whereby digital values are shared by its members (Hesmondhalgh, 2002). These values are transferred from one group to another by new media technologies like the Internet and instant messaging. In this sense, Mexican society assimilates and creates its own Generation X, which is similar to its American counterpart (Leland & Cambers, 1999).

The concept of Generation X is very important as a framework for understanding the development of new technologies, and in measuring their efficiency as educational tools. At the same time, the emergence of Generation X is the result of the development of new media. Younger generations, notably Generation Y, are proving to be even more receptive to the digitalisation of learning. Similarly, educational theory evolves as the needs and learning styles of the new generations change. Learning and digital media obtain mutual benefits through mixing together. This collaborative process, the digitalisation of learning, forms the basis of the thesis model.

1.15 Learning Digitalisation

The Learning and Digital Revolutions have a common thread which is knowledge. The Digital Revolution, according to the previous analysis in this chapter, is making life easier with associated lower costs. The Learning Revolution provides better teaching methods whereby the learner can get the most out of the educational process. It therefore makes sense to assume that the union of both revolutions would produce a better, more cost-effective, and productive learning system. Learning digitalisation may provide an alternative to traditional educational models.

One of the most powerful possibilities of the Digital Revolution is to reduce the distance between users. The field of education that involves distances is Distance Education, a form of education that has been around for years, even centuries. The digitalisation of distance education has led to the term e-learning, and the benefits to education of e-learning are significant and can only increase, as outlined below.

1.16 Distance Education

Distance education or learning, these terms can be used interchangeably, refers to a "method of education in which the learner is physically separated from the teacher. It may be used on its own, or in conjunction with other forms of education, including face-to-face. In distance education, learners are physically separated from the institution that sponsors the instructions" (Rumble, 1989, p. 8). Distance education technologies grew rapidly in the 1990s (Sherry, 1996). As a result, these technologies have become a new means to deliver knowledge that was difficult to communicate in the past, particularly in “low ICT-aware countries” (Eastmond, 2000).

Distance education design adheres to two different paths. The first path is informed by instructionalist approaches to learning. It involves the teacher conveying a specific image of an abstract concept to the learner, who interprets it building their own image and creating new knowledge based on previous experiences. The second path, based on constructivist approaches to learning, involves the learner interacting with the material presented by the teacher. In this case knowledge is a process of negotiation (Tan, et al. 2000; Martens et al., 2007).

Willis (2000) argues that good distance education material follows four steps: *design*, *development*, *evaluation*, and *revision*. In the process of designing distance education, the provider of the material must verify the need for instruction by the learner, analyse the audience, gather data about the possible learners, and establish suitable academic goals. Then, in the development stage, the provider has to create a content outline, review current materials, develop and customise text, and classify and validate content and communication channels. In the evaluation stage, the provider has to verify objectives and targets, create an evaluation process, and perform data gathering and analysis. Finally, in the revision stage, the provider has to develop and implement a revision plan (Willis, 2000).

In addition, a good concept design must consider interactivity, so as to create connectivity between teacher and learner. Absent this, the risk exists of falling back into the traditional educational system and its associated limitations (Sherry, 1996). One way to achieve interactivity is to use graphically rich online environments similar to virtual worlds. However, these are very costly and, in extreme cases, could distract the learner from the objectives of the online material (Young, 2000).

Until recently there were four technological categories used to deliver distance education: voice, video, data, and print education (Willis, 2000). No one technology has been proven to be better than the others. The focus has to be on the learner's needs and suitability to certain technology, as well as to the quality of the content (Willis, 2000). Distance education can adopt three different modalities:

- Home study: where the learner receives their instruction through one of the technologies mentioned above inside their home.
- Study centres: where the learner goes to a particular place to receive the distance course.
- As a supplementary tool to regular classroom classes (Eastmond, 2000).

The process of distance education involves three main participants: the teacher, the site facilitator, and the learner. Each has their own tasks and responsibilities:

- The teacher must be familiar with the content material as well as with the technology used to deliver it. They must be constantly trained in new developments, not only in relation to teaching material, but also in the technology used to provide it.
- The site facilitator supports the teacher in their job. They are the classroom manager in charge of making learning a more pleasant experience.

- The learner must be comfortable working with technology and non face-to-face teacher interactions (Sherry, 1996).

In addition, staff support is required to provide guidance to the distance education process, in areas such as student registration and general administration.

An important issue relating to distance education is its efficacy in comparison with traditional education. Researchers have found that distance education is a feasible alternative to traditional education for the following reasons (Tucker, 2001):

- The method used in the delivery process makes no substantial difference to the learner’s success as long as all of them use the same technology.
- Distance students' scores were higher than those of traditional students in common courses.
- Distance education students perform better than traditional students because they are voluntarily willing to learn, are older, motivated, and self-disciplined.
- Distance education teachers are as good as traditional teachers; the technology has no influence on their performance.
- Distance education learners need interaction. This can be with the teacher or with other students.
- Distance education students perform better if they have permanent contact with the teacher or site facilitator.
- The learning experience can be enhanced if the students develop learning communities with other users in the same class.

- Supplemental technology can provide a motivational environment for the learner (Willis, 2000, para. 3).

Critics of distance education argue that realtime classroom interaction between students, and realtime teacher interaction with students, is critical to learning (Hassenburg, 2009). However, e-learning and the Internet provide a means to overcome this barrier (Irwin & Berge, 2006).

1.17 Evaluation and Costs in Distance Education

Evaluation and cost benefit are two fundamental issues to be considered in distance education. Distance education needs to be cost-effective. Cost must be measured against successful completion rates, and the benefits they provide to society and the economy, not solely on the basis as a dollar cost per student (Sherry, 1996). Evaluation procedures can be formative (as the process is being carried out), or summative (once the process is finalised), or both. In either case, qualitative and quantitative methods must be applied. The variables that must be evaluated encompass: the use of technology, class formats, class atmosphere, the level of interaction among the parties involved, course content, assignments, tests, support services, student achievements, and student attitude (Willis, 2000).

Distance education services are constantly expanding their scope; especially with the advent of the Internet. When Willis's work was published (2000), the Internet was in the process of replacing the four traditional technology channels for distance education: mail, radio, television, and video. Today, e-learning has established itself as a preeminent subset of distance education.

1.18 E-Learning

The European Union defines e-learning “as the use of new multimedia technologies and the Internet to improve the quality of learning by facilitating access to resources and services as well as remote exchanges and collaboration” (CEC, 2001, p. 2). According to *Applicationplanet* (2001), based on figures from International Data Corp, earnings in 2004 in the e-learning world exceeded US$23 billion; more than ten times that of the end of 1999. The U.S. accounted for two-thirds of this figure. Western European earnings grew by an annual rate of ninety-seven percent from 1999 to 2004, making it the world’s fastest growing region. Global e-learning growth in the same period was sixty-nine percent annually. Globally, institutions delivering e-learning doubled their presence from 1,500 in 1999 to more than 3,300 in 2004. Students enrolled in these courses at the rate of a thirty-three percent annual increase during the same period.

1.19 The e-Learning Market

The e-learning market can be divided into four groups based on customer educational characteristics (*elearnframe* report, 2000, p. 9):

- K-12 (K-12)
- Post-secondary (P2)

- Corporate training (CT)
- Lifelong learning (LL)

1.19.i The K-12 Market

In 2000, the U.S. K-12 market encompassed 112,000 public and private schools in 15,000 school districts, with 3.1 million teachers and 53 million students. Spending in this market exceeded US$380 billion in 1999, with US$30 billion dedicated to childcare services and US$352 billion in K-12 (*elearnframe* report, 2000). E-learning is superseeding other forms of distance education in most North American schools by means of digital media in CD-ROM format. At the same time, an increasing number of American families are choosing home-schooling as a method of educating their children. Home-schooling became fully legal in the U.S. in 1993, and it is calculated that approximately one point five to two million children currently receive their education in this form, with a seven to fifteen percent annual increase (The Economist, 2001). There were slightly more than 49 million students enrolled in public k-12 institutions and 5 million in private ones in 2007 in the USA (Digest of Education Statistics, 2009). As of 2007, there were slightly more than 49 million students enrolled in public K-12 institutions and 5 million in private ones in the USA (Digest of Education Statistics, 2009).

1.19.ii The Post-Secondary Market

The higher education system in the U.S. had more than 19.1 million students enrolled in degree-granting higher education institutions, both public and private, and employed approximately 1.4 million people in the year 2007 (Digest of Education Statistics, 2009).

1.19.iii Lifelong Learning

Research into e-learning carried out by Cisco Systems indicates that while initially most e-learning content was developed for IT training, non-IT training-related content now enjoys a far greater presence in e-learning. They also argue, based on information from *E-learning Magazine*, that content has been the main consideration for business executives when purchasing e-learning products, followed by price, and implementation costs (Cisco Systems, Facts & Statistics about e-learning, 2001). Current numbers indicate that the U.S. corporate e-learning market reached US$5.2 billion in 2007 (Ambient Insights, 2008). The entire U.S. e-learning market is currently in the $13 to 17 billion range (Lamont, 2008). Non-IT training-related content has been increasing its share of the e-learning market with the rise in popularity of instant messaging and social network technologies (Roberts, 2008).

1.19.iv Corporate Training

Many web users surf the net with the sole goal of personal learning. According to IntelliQuest, eighty-seven percent of people that use the Internet do so in order to pursue a hobby or a lifelong interest (*elearnframe* report, 2000, p. 58). E-learning in Mexico has been growing steadily since 2000 with approximately forty-three percent of online activities dedicated to education (eMarket report, 2007). The Mexican e-learning market is the second largest in Latin America with 12 million potential users (Barrantes, 2007). It is estimated that forty percent of tertiary institutions in Mexico offer online courses (Barron, 2004).

1.20 The Benefits of e-Learning

The K-12, post-secondary, corporate training, and lifelong learning markets have varying motivations to adopt e-learning. Authors (Andresen & Ahdell, 2001; Meta Media Reasons for e-learning, 2001) suggest that there are six benefits to these markets in adopting e-learning:

- Anytime, Anywhere: The notion that due to Internet accessibility, learners and/or trainers are able to reach material at anytime and anywhere (Loidl, 2009).
- Lower Time and Costs: Many companies claim to have reduced costs by implementing Internet systems and services. IBM, for example, claimed to have reduced US$80 million in travel and hospitality expenditures in 1999 (Forrester research, 2000, quoted in Andresen & Ahdell, 2001). Likewise, "Statistics show that e-learning reduces training time by up to fifty percent from classroom training time, not including the cost associated with paying for a trainer and time away from the work place" (Meta Media Facts and Figures about e-learning, 2001, para. 4).
- Updated Information: Due to the immediacy of the Internet, updated content can reach learners as soon as they require it.

- Customised and Individualised Learning: E-learning can provide individual courses and implement learner-particular pedagogical styles and content
- Feedback and Assessment Tools: E-learning enables the tracking and monitoring of learner progress through the use of assessment tools (Loidl, 2009).
- Collaboration Among Learners: Chat groups, e-mail, social networking sites, Twittering, and so on, allow learners to share their knowledge acquisition experiences (Andresen & Ahdell, 2001).

Aside from the above benefits, there are other reasons behind the spread of e-learning. Moe, Bailey, and Lau (1999) of Merrill Lynch, argued that there are six *new economy mega trends* behind e-learning:

- Changing Demographics: An aging population, ethnic diversity, and Generation X's entry into the workforce.
- The Technology Revolution: The emergence of the Internet as a communication channel, the digitalisation of learning, and the automation of processes.
- Globalisation: The mobility of both highly-skilled workers and e-commerce.
- Branding: Online presence through brand names, e.g., Harvard courses online.
- Consolidation: Big companies buying e-learning startup companies in the maturation of the e-learning industry.
- Outsourcing and Privatisation: Companies outsourcing some of their training materials to external and sometimes remote providers.

However, there remain some obstacles to overcome and concerns to consider before implementing e-learning solutions.

1.21 The Obstacles to e-Learning

Currently, the most important technical obstacle to effective and increased use of e-learning is bandwidth. Heavy traffic on the Internet has discouraged some companies from joining the trend of adopting e-learning technologies (Terry, 2000). Nonetheless, it is reasonable to assume that advancements in technology will eliminate or reduce such problem in time (Hearn et al., 1998).

Resistance to the adoption of e-learning practices can also be seen to lie in concerns about the transition from the classroom to the e-learning environment (McPherson and Nunes, 2008). For example, a report from the Philipine Institute for Development Studies by Macapanpan (1998, quoted in Ramos, 2001) mentioned that during an MBA course that some of his students preferred not to work with the new technology because they were more comfortable with face-to-face interaction (Ramos, 2001). Terry claims that "according to a 1999 International Data Corp. survey of training, business-unit and IS managers, users' (of e-learning) biggest concerns are the lack of human interaction, the inapplicability of e-learning for some content and the unsuitability of e-learning for some learners. Those who've never tried it (e- learning), on the other hand, cite as chief obstacles the lack of employee desktop access, difficulty in monitoring and track usage, and the lack of conviction from management" (Terry, 2000, para. 3)

Additional obstacles faced by e-learning include some opposition in the educational arena from professors who argue that it is very difficult to substitute face-to-face interaction with a computer. However, some contend that the real motivation of such opposition lies in the threat that online education presents to the bureaucratic structure of the North American, and other, educational system (Santosus, 1998). Like Santosus, McPherson and Nunes (2008) believe that the slow adoption of e-learning in some quarters is related to the new communication paradigm it represents and the degree to which it has taken many academics by surprise.

Andresen and Ahdell (2001) suggest that e-learning faces three fundamental problems:

- It is hard to measure: They refer to data from Forrester Research (2000) indicating that two-thirds of managers do not carry out achievement assessments of their web-learning operations.
- It is underused: Many online courses experience high drop-out rates.
- Its content is boring and text-heavy: Too much e-learning content is text-based, static content with weak interactivity.

This third criticism is shared by Prensky's (2007) view of e-learning. He states that contemporary e-learning material follows what he calls the "tell-test system", where content is delivered as lectures or readings on a screen and then tested. According to Prensky, this is boring to the learner and hence ineffective. By contrast, he recommends using video games or what he refers to as *digital game-based learning* (Prensky, 2007).

Both Prensky (2007) and Andresen and Ahdell (2001), suggest that e-learning content is currently too plain, and that it would profit from the dimension of interactivity that the inclusion of play theory would provide. They claim that this would lead to greater engagement on the learner's part, in much the same way that a teacher engages a student. The notion of incorporating play theory originates from the notion that emotions form part of the learning process.

This thesis proposes the concept of e-Ludic learning as a form of e-learning characterised by dynamic and interactive content, which is delivered through a playful format. As the following chapter will demonstrate, e-Ludic learning is equipped to tackle the passive content/format criticism levelled against e-learning. The next chapter explains the meaning of e-Ludic learning in detail.

CHAPTER II: E-LUDIC LEARNING

2.1 LUDIC WORLDS

2.1.i Ludic?

Different perceptions surround the term ludic. It traces its origins to the Latin word *ludus*, which means game. While play and game appear to be synonymous, Frasca (1999) points out that there is a difference between them: play has no rules, while games have rules. Frasca (1999), based on Lalande (1928), goes further, arguing that play and game are two divergent concepts. Where games can be seen to have a result, a winner or loser, playing does not. In contrast, others such as Vidart (1995), contend that play does actually have rules but that they are less strictly defined than in games. For the purpose of this thesis, the word ludic refers to play. A ludic world is a play world. Play is understood to be a pleasant experience independent of the results of Play Theory.

2.2 Play Theory

Playing has different conceptions among distinct cultures throughout history (Sutton-Smith, 1995). In standard idiom play is defined as the opposite of work, as in the expression “work and play”. However, it has been observed that while play is ostensibly the opposite of work, work can involve play and therefore be enjoyable (Blanchard &

Cheska, 1985). Play itself has four different conceptions: *play as power*, *play as progress*, *play as fantasy*, *and play as self* (Pellegrini, 1995). The concept of play as progress is of particular interest to this thesis. It encompasses the belief that the goal of playing is learning. The question is, do we really learn from playing?

Brougere (1999) explains that both children's play and adult simulation/gaming are an important element for education and training, constantly emerging from different frameworks. She argues that while adult education looks for different ways to adapt simulation/gaming into a formal education system, preschool education is often comfortable relying on the *play ethos*, the notion that all play is good (Smith, 1995). Brougere (1999) adds that the investigation of children's play has led to results that could broaden the analysis of simulation/gaming situations. The adult/child dichotomy, she argues, is a falsehood, based on two centuries' of development based on a conception or an assumption of childhood as being incommensurable with the adult world. Moreover, there exists, according to Brougere (1999), a much simpler dichotomy that delineates learning types; formal learning vs. informal learning. This dichotomy leads Brougere (1999) to consider play in the following combined way:

- Play as a leisure activity and as entertainment, encompassing informal, unintentional, and haphazard learning for both children and adults.
- Play as a constructed or reconstructed environment within the domain of formal learning, whether scholastic or not. While an activity may correspond to play, the fact that the educator develops a curriculum

according to educational objectives means that it defeats the purpose of the former conception of play as unstructured leisure.

As adults we can learn while engaging in leisure play, but it is an informal type of learning not linked to precise objectives. Brougere (1999) remarks that it is assumed that children initially engage in basic learning through play in its freest form, and then graduate to games/simulations that place more emphasis on debriefing and reflexivity, and which therefore enable the passage from play to more advanced learning. In this light, adult games/simulations are a form of *play as progress*, which occurs in sequential order, has rules, and uses debriefing. Nonetheless, as her main argument, Brougere concludes that play as leisure is another form of play as progress.

The remaining concepts of play are linked to particular attitudes. *Play as power* has to do with contest and competitions. *Play as fantasy* sees playing as a way of liberating the mind and engaging the player in a creative process. *Play as self* is where the mere experience of playing is what matters (Sutton-Smith, 1995). Play in its four dimensions can be seen to be a motivating factor in problem-solving and knowledge construction. However, as Glickman (1984) suggests, play acceptance or rejection depends on the educational policies in place. He argues that when the goals of education have short-term benefits with narrow objectives, such as those measured in a standardised test, play is viewed as wasteful and distracting to students. By contrast, when the objective concerns the long-term development of the individual, play is viewed as a motivating factor.

Therefore play and education can be said to work well together in any student- or teacher-centred approaches to education where the development of, and knowledge acquisition by, the individual prevails over any set or specific group standards. Play is enjoyable, and when play and education are combined, education can also be enjoyable. The key is to find the right balance between play and educational content.

A similar perspective can be found in Stephenson (1967). He distinguishes two main concepts: *social control* and *convergent selectivity*. The former relates to our religious beliefs, political aspirations, and status as subject to social control. The latter refers to new or non-traditional forms of behaviour such as fashion, fads, and fancies where no social control is imposed. Mass communication encompasses both. Public opinion is delimited by social control. By the same token, convergent selectivity, which involves advertising, drama, and art, enables us to free ourselves to a certain extent from social control. Moreover, according to Stephenson (1967), mass media provides both *communication pleasure* and *communication pain*. Entertainment is as form of communication pleasure in which people interact without expectations. It brings no material gain and strictly serves no work function, but induces certain elements of self-enhancement such as play, enjoyment, contentment, serenity, and delight. By contrast, communication pain is a command for work and action, for effort and production. Education and the development of skills are subject to communication pain.

Following Stephenson's (1967) logic, if education is communication pain, then it may be more effective if infused with communication pleasure. While e-Ludic learning environments involve communication pleasure, in the delivery of learning content they can also be seen to embrace communication pain. The significance of this conclusion is that by adapting education to ludic environments, we can infuse education with communication pleasure, and thereby enable the individual to achieve greater level so self-enhancement and self-fulfilment.

For an interactive learning environment to be considered ludic it must engage elements like fun and pleasure in a creative display. The process of blending education with electronic or digital formats is what I refer to as ludic learning. When it occurs online, it is what I term e-Ludic learning. As Dix contends: “Many of the best ways to teach children is to involve putting them in an environment with the right prompts and material and letting them investigate and play within that carefully selected place” (Dix, 2003, p. 5). Different methods exist to blend education with ludic worlds. Moreover, this is not a new idea. Traditionally, the integration of entertainment and learning has been known as *edutainment*. Edutainment is part of a more general concept that denotes interactive learning environments.

2.3 Interactive Learning Environments

Aleven et al. (2003) define interactive learning environments as: “computer-based instructional systems that offer a task environment and provide support to help novices learn skills or concepts involved in that task. This support may be in the form of hints and feedback, opportunities for reflection, or simply by making available a space of linked information (e.g., hypertext pages) that is likely to be relevant to the learner” (p.279). Interactive learning environments involve interactivity between the user and the computer or electronic device. Learning is embedded as content and the user experiences knowledge acquisition while interacting with the environment. E-Ludic learning is an interactive learning environment that involves ludic principles within engaging content elements.

Ludic formats are based on the principles of play theory in which interactivity and play are closely related. The degree of ludicness (playfulness) is directly related to the degree of interactivity. Video games, by nature of involving a high degree of interaction, are therefore highly ludic.

There are four levels of interactivity as indicated by Schweir and Misanchuk (1993):

- The first level, the *reactive* level: refers to a response to a given stimuli.
- The second level, the *proactive* level: occurs when the user controls the answers and the designer of the software has no control over all the possible outcomes.
- The third level, the *mutual* level: occurs when the environment is built on the user's input in realtime interaction between the user and the program.
- The fourth and last level is almost at the level of artificial intelligence.

This classification of interactivity into levels provides a design framework for defining the degree of interactivity of a software program. The design framework questions are:

- What is the degree of ludicness in a proactive interactive environment, as compared to a purely reactive environment?
- Do we learn from interactive and ludic environments?

To answer these questions it is important to understand the nature and meaning of ludic as an emotion and its relation to learning and cognition.

2.4 Emotion and Cognition

Behavioural and cognitive theories have largely been derived from objectivist philosophies where the effects of emotions in learning are of little importance. Traditionally, a parallelism has been drawn between cognition and emotion, with cognition being defined as structural and rational, and emotion regarded as unpredictable and irrational (Price, 1998). Greenspan's (1997) model of dual-encoding indicates that every sensation creates an emotion. These emotions integrate with cognition, motivation, and actions in emotional patterns. Learners process information both cognitively and emotionally, and positive emotions enhance the learning process. Consequently, emotional patterns must be considered in the design of learning formats (Um et al., 2007).

Researchers like Tennyson and Nielsen (1998) and Um et al. (2007) argue that the learner's emotions and motivations influence the acquisition of knowledge, their attention, and their attitude. Their explanation is supported by complexity theory that deals with unpredictable situations where learning is problematic to determine.

The emotion, motivation, plays a very important role in respect to attention. Motivation can be intrinsic or extrinsic (Gagné, Briggs & Wager, 1988), and both types of motivation involve the user's sense of challenge, achievement, frustration, rewards, and so forth. Learners must be motivated and engaged in the cognitive process. An important concept in motivation is creativity. Creativity produces motivation and engagement in the learner. It is also understood to be a motivational factor in so far as it represents change and variation. The creative design of the content format is a strongly and positively motivating and engaging factor (Um et al., 2007).

Research has established a relationship between creative thinking and play. Some of the emotional and mental processes that take place in developing creativity also take place in play (Russ, 2003). A creative environment provides a playful setting that engages the user. Playfulness is an internal state experienced by the individual. To talk about an activity is not the same as to actually play the perceived activity (Howard, 2002). The individual's perception of an activity as play is what engages him/her in that activity. E-Ludic learning aims to make activity playful and educational.

2.5 WHAT IS E –LUDIC LEARNING?

I define e-Ludic learning as the combination of e-learning and play theory. In current ICT terminology the letter *e* indicates that the delivery and access method is through an online channel. In other words, the difference between a ludic learning environment and an e-Ludic learning environment is how the user accesses the content. E-Ludic learning content is accessed through a computer that is connected online to the Internet, while ludic learning is accessed offline through a CD-ROM.

The *e* factor also represents a smaller range of design possibilities due to bandwidth. Bandwidth affects the design possibilities or interface presentation of an e-Ludic learning environment in relation to that of a ludic learning world. Offline ludic learning software like edutainment CD-ROMs have more features and appealing interfaces than online versions. Nevertheless, online environments still have appealing interfaces and as the bandwidth increases so too will the improvements for online settings. The reasons for considering online environments come as a result of the benefits that the Internet provides as a new medium.

2.6 E-Ludic Learning Implementation Model

I propose that e-Ludic learning involves any learning theory that suits the user. The content must have playful elements and evoke playfulness in an interactive interface delivered in an online format. The learning methodology must take into account different aspects of current learning theories and match them to the user's learning needs and styles. The user's learning requirements can be classified according to their levels of knowledge.

2.6.i Levels of Knowledge

Baumgartner (2001) indicates that the main learning theories (behaviourism, cognitivism, and constructivism) match five different levels of knowledge that the learner can have about a particular content:

- Level one, called *Novice* involves *Know that*: Novices have no familiarity with the learning material. They first need to learn the fundamental rules and facts without questioning. Novices have not had any related experience of the content. They can only apply the acquired content to real settings with the supervision and guidance of an external agent because they are as yet unable to decide which rules apply best. Behaviourist instruction matches users' learning needs at this level.

- Level two, called *(Advanced) Beginner* involves *Know how*: Beginners usually commence to differentiate situations and cases applying rules based on their context. Beginners cannot yet operate without associated guidance and control; nonetheless, they have more variations concerning skills execution. Combined behaviourist and cognitivist instruction suits this type of learner.

- Level three, called *Competence* involves *Rational Understanding*: Competent learners have reached a stage where they can distinguish various cases and which solutions best apply to them. They understand the rules relating to being able to act independently within their domain area and perform problem-solving activities. In spite of their abilities, competent learners have yet to gain the intuition that expert learners have. Decision-making at the competence level is still difficult. Cognitivist and constructivist instruction can help the competent learner achieve proficiency as automaticity.

- Level four, called *Proficiency* involves *Implicit Understanding*: Proficient learners perceive their tasks as being connected to feasible solutions. They have a comprehensive perception of any given situation related to the knowledge they have gained. Constructivist and automaticity instruction work well to provide the next step from proficient to expert.

- Level five, called *Expert Intuitive* involves *Intuitive Action*: Expert learners achieve the most efficient connection between tasks and their possible solution in regard to specific content. They are able to perceive and construct links between various problem solving alternatives. Experts construct cases out of ostensibly unlinked, chaotic, and unclear situations that already have defined solutions. Constructivist instruction is recommended here to enable experts to construct new knowledge from the knowledge they already possesses. Automaticity is achieved at this level.

An understanding of the level of knowledge that a potential user already has about the content to be delivered by an e-Ludic learning environment, provides a supporting tool in choosing the right learning theory. There are different ways to obtain this level of knowledge, for example, by implementing a test or by simply observing the user's age.

Once the level of knowledge has been determined and the corresponding learning theory is identified, the process of embedding the content into a ludic format can commence. Howard (2002) emphasises the need to understanding the meaning of playfulness. He argues that the content must be perceived as play by the child. Children's perception of the learning material as playful brings the benefits associated with play to the learning content: motivation, engagement, enthusiasm, and willingness to participate. To make specific content playful from a child's perspective requires an understanding of a child's comprehension of play.

Research has found that children distinguish play from other activities, considering it as fun and free of rules. The ideal scenario for an e-Ludic learning design would be to include all of the children's perceptions and opinions in a playful setting. However, ascertaining all the children's opinions about a ludic environment is a complicated task and falls outside the scope of this thesis. Instead, this thesis explores e-Ludic learning in low ICT-aware areas, characterised by socio-economic limitations. Kishiyama et al. (2009) found that children from low socio-economic backgrounds have low playing skills. He also found that teaching children from low socio-economic background some playing skills actually increased their cognitive skills. The subject of low ICT-aware and low socio-economic backgrounds in the context of e-Ludic learning is discussed in depth in Chapter Four.

Howard (2002) found that children form their perceptions about work, play, and leisure based on external and emotional experiences. The classroom and the teacher's role provide an initial dividing line between work and play. Howard (2002) proposes a framework (Table 3) of how play perceptions may come to be developed and recalled.

Table 3. Childrens' perceptions to evoke playfulness

Situation	Response
Space and constraint	In established areas like a classroom, children learn that work happens in a specific place, while play happens anywhere. When that division is not evoked, children feel more playful toward various activities.
Teacher presence	Adult involvement in all children's activities helps to develop a sense of playfulness with an adult presence. When the child is not used to adult participation in play they create a dividing line between work (adult presence) and play.
Positive effect	Positive elements such as motivation and creativity in classroom activities creates a playful environment.
Skill development	The emphasis in skill development needs to be on the processes rather than the results. The sense of play is lost the moment the focus is on the outcome and not the process.
Choice and control	From the moment the children perceive that they have control and choice over the activity, they start to develop a more playful feeling towards the activity.

Note (Adapted from Howard et al., 2003, p. 23)

A playful environment is achieved in e-Ludic learning if the user perceives it as playful. In other words, playfulness becomes an internal process based on the mindset of the user. As mentioned, the ideal situation would be to design the environment interface based on the children's opinions. However, the practical choice is to research playful activities and integrate them into the environment. Once a playful environment is established it must then be combined with the learning content. This leads to the following questions:

- What amount of ludicness is required to maximize the learning experience?
- How engaged must the user be to achieve a better understanding of the material?
- How digital and interactive must the format be in order to maintain the right combination between learning and playfulness?

The concept of flow provides a theoretical framework to answer these questions.

2.6.ii Flow Theory

Flow theory is based on the concept of *flow* by Mihaly Csikszentmihalyi (1990). Csikszentmihalyi explains that flow is a stage of complete happiness and satisfaction that an adult experiences during certain activities. The adult can become so engaged and involved in a particular activity that anything else becomes redundant and simple. The ability to maintain attention and concentration in a particular activity is fundamental to reach the flow stage. Flow stems from activities that bring enjoyment. Enjoyment is achieved when a particular activity provides clear goals, feedback concerning the outcomes of the goals. Attention is hereby maintained at a high level and the activity liberates the person from extraneous thoughts, leads them to feel in control, and causes them to lose track of time. A challenge is maximized as the person's consciousness of him/herself disappears (Sherry, 2006).

The objective for e-Ludic learning must therefore be to combine the appropriate degree of ludic experience with learning content in order to maximize flow. Moreover, as indicated above, the learning perspective employed must contain the most appropriate learning theory concepts, be they behaviourist, instructivist or constructivist.

So far I explained the meaning of e-Ludic learning environments and the importance of the right combination between the learning and ludic components. The following paragraphs outline the model good e-Ludic learning design must follow.

2.7 THE MODEL

Figure 6 exhibits the e-Ludic learning model that I propose. The integration of the Learning and Digital Revolutions constitute the foundation of e-Ludic learning. However, while e-learning is the product of digitalising learning, e-learning formats by themselves are not enough, as Prensky (2000) suggests. By assimilating the features of ludic learning derived from play theory, e-Ludic learning can be seen to emerge as a powerful educational tool.

E-Ludic learning design requires four elements:

- Learning theory approach
- Ludic element

- Learning content
- Online delivery

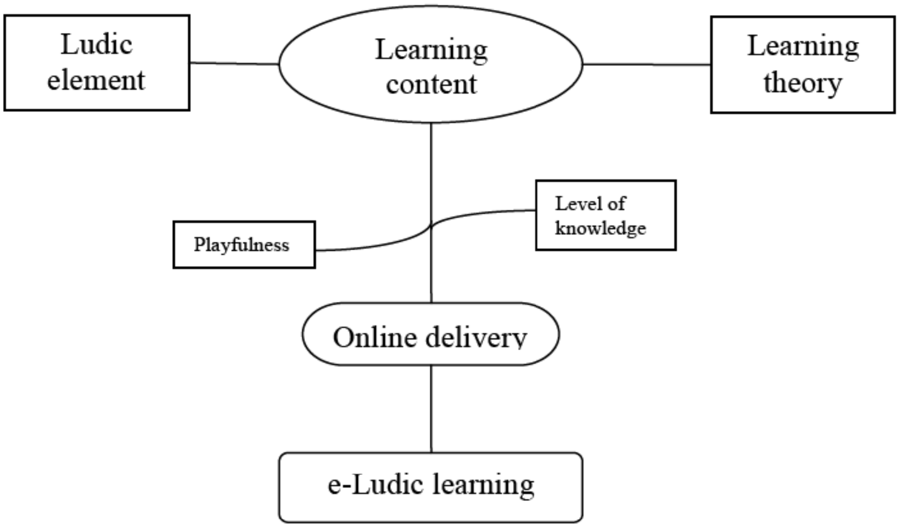


Figure 6. E-Ludic learning model

In the e-Ludic learning model above, the ludic element and learning theory have the same importance. The ludic element has to deliver choice and control to the user to evoke playfulness (Howard, 2002) and strive for motivation to engage him/her through the use of positive emotional patterns (Um et al., 2007). Good e-Ludic learning design has to identify the level of knowledge the prospective user has of the learning content (Baumgartner, 2001). The design features derived from the learning theory selected must walk the user through the different levels of knowledge proposed by Baumgartner (2001). These features must include ludic elements in the content presentation.

The e-Ludic learning environment that I designed and programmed for this research included the four elements mentioned above. The learning theory approach was automaticity, the ludic element was a random number generator process, and the learning content was arithmetic instruction. The environment was delivered online and hosted on an Australian server. A more thorough account of this model and its implementation is presented in Chapter Five.

E-Ludic learning encompasses a host of new media formats that have emerged with the Digital Revolution and whose use is growing exponentially. Specifically, these include edutainment, video games, and digital game-based learning environments. The evolution of offline digital formats has grown faster than online digital formats due to technical factors. Bandwidth has been the main obstacle in the advancement of online digital formats (Kruse, 2008). However, while bandwidth has limited the capabilities of e-Ludic learning design up until now, as the speed of data transmission increases, e-Ludic learning will come into its own. Eventually, online and offline learning environments will have similar interfaces and capabilities.

In the developing a taxonomy for e-Ludic learning design, it is important to observe the evolution of education technologies and their integration into offline and online settings. Thus far I have described the Learning and Digital Revolutions and the concept e-Ludic learning. In the next chapter I describe the evolution of e-Ludic learning.

CHAPTER III: THE EVOLUTION OF E-LUDIC LEARNING

E-Ludic learning is the result of the amalgamation of different technological and learning developments in recent times. Chapters three and four provide a theoretical framework for e-Ludic learning by explaining the concepts behind it. This chapter explores the history of e-Ludic learning, providing an account of its past applications. Some representative software is introduced, in order to provide a practical framework. This framework provides an e-Ludic learning taxonomy for designing e-Ludic learning applications.

3.1 THE ORIGINS OF E-LUDIC LEARNING

The origins of e-ludic learning can be traced back to the start of the integration of ICT and education. According to Plomp et al. (1996) "The 1980s have been identified as the period where personal computers (PCs) replaced data processing machines, specifically in business, and where they also became popular for use in the home as well as the classroom. The majority of educational institutions in the developed world started to incorporate computers as auxiliary learning tools at this time" (Plomp et al. 1996, p.1).

Innovative educators have used computers for the past 20 years but their vision for digitalised learning was not fully realised until the emergence of the Internet. The emergence of the Internet in the past two decades has even overshadowed the concurrent rapid advancement in computer technology, and has greatly increased expectations surrounding digitalised education. Although different explanations have been given regarding the obstacles to incorporating computers into the learning dynamics of educational systems, there is no conclusive research about the subject (Plante, 2004).

During the 1960s and 1970s there were two main hypotheses about the future of computers in education. One group of analysts believed that computers were heading in the same direction as educational radio and television. The other group were convinced about the future development of learning systems with artificial intelligence capabilities (Leonard, 1968). However, since its inception, educational computing can be seen to have emerged along five independent paths.

The first path commenced in the 1920s with the birth of computer assisted intelligence (CAI). The American, Pressey, conducted work on mechanical teaching machines and self-scoring tests (Smith & Smith, 1966). The U.S. military supported Pressey's investigations into computer-aided instruction, as well as the incorporation of state-of-the-art inventions in hardware and software. New CAI software emerged due to this support, resulting in the development of multiple learning materials from different media (Smith & Smith, 1966).

The second path started in the 1960s when computer programming became a school subject and programming became the new computing paradigm. Luehrmann and Peckham (1984) argued that computer use was incomplete if the user did not also know how to program. During this period, programming and computer literacy became interchangeable terms (Dwyer & Critchfield, 1978). Many new applications were developed, which in turn created the need for new training in the use of these applications.

In the third path, the work of people like Brown and Lewis (1968), and Papert (1981), revolutionised the notion of what could be achieved using computers in education. This path predicted and then facilitated the use of computers to achieve quantifiable gains in human cognitive development and problem-solving. Programming and application implementation came to constitute computer literacy in this period.

The fourth path coincided with the emergence of the Internet, and involved its development as an information-collecting instrument and a cognitive and problem-solving tool. At this time, knowledge became accessible to anyone, anywhere due to the interconnection via the Internet of computers among different schools and universities in the developed world (Siriginidi, 2008). Information that was formerly only accessible to those living areas city or university libraries, now became accessible to remote schools. Educational institutions connect to the Web en masse, enabling the exchange of information and knowledge between teachers and schoolmates. School curricula, teacher training, and other learning materials come to be shared through websites. Most learning software is now designed for the Internet and only bandwidth remains a limitation (El-Khouly, 2008).

ICT has come to replace traditional forms of distance education such as correspondence schools and educational television. Computers dominate administrative offices in educational institutions, departments, and ministries, with learning management systems and databases now indispensible to the education sector (Dlodlo, 2009).

The fourth path evolves into the fifth path when the Internet and content development are combined and transformed into new educational tools. In the fifth path, content is considered as a way to realise the integration of computers and learning through the Internet. This path includes e-learning, multimedia, edutainment, ludic learning, and e-Ludic learning. Here, play, represents the motivational element to gain the user's attention as touched on in Chapter One. The following section explains how play has been present in education for years.

3.2 The Incorporation of Play

The first recorded connection between play and education is found in Plato's Republic. Plato presents play as the best pedagogy to achieve the Polis or *just city* (Plato's Republic, 2000). After Plato's initial conceptualisation, play-learning became more of an activity for children, where it largely remained as an educational tool for pre-school education. In the 1960s play was again considered as an educational tool due to the emergence of multimedia. Computer-based learning formats adopted play as an engaging element. These models were merely stand-alone applications. The method of access for students and teachers was through CD-ROMs. Ludic learning applications flourished in this era, specifically edutainment.

In the intervening years, edutainment has become increasingly sophisticated and commercially-orientated. Stand-alone applications have been relatively successful due to the fact that they are played individually. Nonetheless, the emergence of the Internet has created the opportunity for networking, information sharing, and multi-playing. The

Internet is the basis for e-Ludic learning and has made distance learning and asynchronous instruction possible. However, ludic learning products like edutainment and simulations are currently more appealing than contemporary e-Ludic learning applications due mainly to bandwidth size. In many locations Internet speeds remain slow. Because of this limitation, e-Ludic learning applications are yet to enjoy extensive penetration of the marketplace. Compared to CD-ROM-based ludic learning, current e-Ludic applications appear quite basic. However, technological progress in infrastructure and connectivity will soon permit the reproduction of CD-ROM content in online settings (Kennedy, 2006).

3.3 LUDIC WORLDS AND LEARNING

3.4 Edutainment

The integration of education and ludic environments has been around since the 1970s. Although the term edutainment only gained widespread currency in the early 90s, the phenomenon itself can be seen to have existed since the 1970s with such seminal childrens' television programs as Sesame Street. Edutainment is "a neologism, similar to infotainment, which expresses the marriage of education and entertainment in a work or presentation such as a television program or a website" (Techterms, 2008, para. 2).
The sophistication of computers, multimedia, and CD-ROMs has provided an additional place for edutainment next to television. The introduction of interactivity as the fundamental tool to gain children's attention has ensured edutainment's ongoing success. Interactivity enables direct participation, and with it the possibility of observing and trying out learning materials (Shields, 2003).

In this thesis, edutainment is conceptualised as a fun learning format for children, particularly preschoolers. Assuming that entertainment is a ludic environment, we can characterise edutainment is a ludic *learning* environment. By extension, e-ludic learning can be characterised as *e-edutainment*. To avoid confusion, the term edutainment encompasses multimedia CD-ROMs as depicted in figure 9. Generally speaking, the term edutainment is linked to commercial and marketing strategies. It should be noted that as time goes by, those children who have been involved with the edutainment world will be more comfortable learning while having fun as adults. However, the learning process as it relates to adults down the track is a research topic beyond the scope of this thesis.

Currently, there are many products on the market that can be classified as edutainment. The *Jump Start* series by Knowledge Adventure (visit www.jumpstart.com) provides different edutainment software CD-ROMs for children ages 18 months to 12-years-old and upwards. Most of these products aim to reinforce and maximize basic skills like maths, reading, phonetics, and language. The Jump Start series includes more than 17 products aimed at different age groups. Among them are the *Math Blaster* series by Knowledge Adventure and Vivendi Universal games, which develops skills such as addition, substraction, calculating weight, sorting objects, and logical thinking.
The Learning Company, acquired by RiverDeep Group, has developed almost 60 different titles including *Arthur, Reading Rabbit*, and *Carmen Sandiego*, to name just a few of their more memorable characters (Broderbund, 2003). Perhaps the most popular edutainment products are those related to the enduring children's TV series, Sesame Street (Proudfoot, 2009). A representative Sesame Street-based product is *Search and Learn Adventures*.

3.4.i Search and Learn Adventures

Sesame Street Search and Learn Adventures is an educational software CD-ROM developed by Creative Wonders, a branch of the Learning Company, together with the Children's Television Workshop of Sesame Street. It targets children from three to six years of age and may be played with the guidance of either a parent or an adult. *Search and Learn Adventures* is a game environment that features a leading detective character named Sherlock Hemlock and his dog, Watson. The story begins when the detective receives a telephone call asking for help. Sherlock Hemlock then heads to the set of Sesame Street where the adventure unfolds. Munford the magician, accidently makes all the items for the Muppets´ beach party, picnic, or trip disappear. Hemlock is enlisted to help find the missing objects. To fulfil his assignment, Hemlock must explore different places: Zoe at the Castle Gate, Count Von Count in his castle, Big Bird at Finders Keepers, Oscar the Grouch on Sesame Street, and Grover at the Fury Arms Hotel. During his odyssey, special guests such as Elmo, Cookie Monster, and Fat Blue make cameo appearances.

From the outset, the user plays the role of Sherlock Hemlock's auxiliary detective as an off-screen character. Hemlock assumes a coaching position and the user has to solve various challenges in order to accomplish the tasks given to Hemlock (Figure 7).

Figure 7. Sherlock with Watson and Grover (Search and Learn Adventures CD-ROM)

The game has three levels that the user can select. These ascend from easy, to average, and on to difficult. Each level represents the number of items to be found and the amount of learning activities to be accomplished. The player also has to overcome certain degrees of difficulty. He/she is required to solve various puzzles and problems through pattern recognition, matching, sorting, and object recognition activities. The *Sesame Street Search and Learn Adventures* help guide outlines the seven locations that the user needs to go through, the associated educational goals, the levels to be achieved, and the skills required. For example:

3.4.ii The Zounds with Zoe Game

- Location: On the street in front of the Castle Gate.

- Educational goal: To help the user practice memorising and duplicating a short sequence.
- Level: 1. (Not present); 2. Repeat a sequence of three; 3. Repeat a sequence of five.
- Skills: Memory, sequencing, and observation.

The guide included for parents provides advice on how they should guide their child during the game in order to derive the most benefit from it. It is significant that the user is encouraged to use their mouse in the first physical interaction with the computer. Although more research is needed on the subject, the use of the mouse by the child participant could conceivably provide him/her with a nascent understanding of the concepts of power and control. According to the developers of *Search and Learn Adventures*, the software provides the user with over 20 activity combinations. The developers also argue that the user learns:

- Logic: By helping the Count complete the "magic picture".
- Real world skills: Such as playing the recycle game.
- Memory: By finding matching items in the Big Bird Store.
- Following directions: By delivering certain groups of food to the rooms at the Furry Arms Hotel.
- Exploration: By searching for hidden rooms and secret passageways.

At first glance, and after having played the game, it may seem likely that the aforementioned skills and abilities will be achieved in the child's mind. However, there is no current methodology or measurement to establish the game's efficacy.

3.5 The Effectiveness of Edutainment

Perhaps the greatest obstacle faced by edutainment is its perception within the research community. The very term edutainment bespeaks a marketing strategy more than a field of legitimate academic investigation. Nevertheless, many edutainment design features are taken from pedagogical learning theories, as can be read in any edutainment CD-ROM handbook or educational technology journal, such as *Eurocall* (2008). In recent years, greater academic acceptance of edutainment and the emergence of video games, has led to the emergence of the concept *digital game-based learning*. This new term, as explained in the first part of this chapter, involves the use of video games as educational tools (Adcock, 2008). Video games are the most popular form of ludic world (Adcock, 2008). They evoke playfulness and engagement, while maintaining ordered rules (Prensky, 2007).

3.6 Video Games

A video game is "any form of computer-based entertainment software, either textual or image-based, using any electronic platform such as personal computers or consoles and involving one or multiple players in a physical or networked environment" (Frasca, 2001, p. 4). Recent years have seen the emergence of computer game studies using academic definitions. Thus, according to Travinor, "X is a videogame if it is an artefact in a digital visual medium, is intended primarily as an object of entertainment, and is intended to provide such entertainment through the employment of one or both of the following modes of engagement: rule-bound gameplay or interactive fiction" (Travinor, 2009, para. 23).

To this definition, it is necessary to add a third mode of engagement, namely the delivery of video gaming through the Internet as occurs in online gaming.

3.6.i Video Game History

According to Herz (1997), the first video games were developed in 1962. Initially, they took the form of rudimentary paddle games along the lines of ping pong, pinball, and hockey. *Space Invaders*, in 1978, was the first video game with animated characters in the form of sci-fi aliens, athough these characters lacked personality attributes. The next videogames were *Asteroids*, *Battle Zone*, *Defender*, and *Missile Command*, and these followed the same character pattern as *Space Invaders*. The player faces an identified enemy in the form of a basic personality character. Thereafter came a host of characters such as *Pac Man's Shado*, *Speedy*, *Bashful*, *Pokey*, *Blinky*, *Pinky*, *Inky*, and *Clyde*, all lacking personality attributes. It was not until the early 80s with *Donkey Kong*, that the main character came to have well-developed character attributes. *Donkey Kong*'s successor, *Super Mario Bros.*, emerged in 1985 to become a global cultural phenomenon, thereby marking the real departure point of mainstream video games mania. This was due in no small in part to the incorporation of personality traits into the main character, Mario, (the little plumber who could) not previously linked to computer terminals and controllers; namely humour and wit (Sheff, 1993). The history of *Super Mario Bros.*, as described by Sheff (1993), represents one of the more interesting legends of the video game industry. It traces its origins back to the Hanafuda, a flower card game that gained widespread popularity in Japan at the end of 1880s. The Hanafuda was developed by the Yamauchi family, founders of the Nintendo Company. A century later *Super Mario Bros.* grew into a cultural icon and the basis of a media empire, through the work of Nintendo designer Shigeru Miyamoto. By 1994, in what was known as the Next Generation Era, Sony Play Station, Sega Saturn, and Nintendo 64 had emerged (Herz, 1997).

Perhaps the main reason for the ongoing development and sophistication of video games has been the revenues they produce. By 1997, annual sales for the video games industry worldwide reached the seven billion U.S. dollar mark, two billion more than Hollywood's profits for the same year (Dorman, 1997). More recently, the Entertainment Software Association (ESA) indicated that the sales in the U.S. at the end of 2008 reached 297.6 million units, with revenues of approximately US$11.7 billion (ESA Sales and Genre, 2008). It is currently estimated that sixty-eight percent of American homes play video games, with an almost even split between male and female players (ESA Game Player Data, 2008). These eye-catching sales and audience figures have drawn considerable attention to the video game phenomenon. However, video games are not set apart from other media by sheer dint of numbers. They are an evolving communication medium in their own right, and a new art-form with their own particular genres and classifications (Poole, 2000).

Video game genre classification is a subject of some debate. Wolf (2000) considers interactivity as the main component in video game genre classification, followed by iconography and thematic subjects. He also introduces the concept of the "player-character" as the framework for understanding interactive genres. With this in mind he sets out to describe almost 40 different genres.

Despite this diversity of genre classifications, there are features common to all video games that explain their appeal. The foremost of these is interactivity, which characterises video games as *active media*. Another feature is the idea of power or control contained within the concept of interactivity (Brody, 1993). Video game players tend to compare the activity, not to watching TV, but to sport or sex, where the user is a performer and not simply a viewer (Turkle, 1984).

Prensky (2000) suggests that video games are the most engaging activity to have emerged in recent years because they are "fun to play, have rules, goals, outcomes and feedback, win states, conflict/competition/challenge/opposition, problem solving, interaction, representation and story, and are interactive and adaptive" (p. 106).

The British Board of Film Classification (BBFC) published a report in 2007 about video game playing. The report indicated that:

- Female game players tend to prefer *strategic life simulation* games like *The Sims* and puzzle games, and spend less time playing than their male counterparts.

- Male players favour *first-person shooter* and sports games, and are much more likely to become deeply absorbed in play.

- Younger game players are influenced by peer pressure and word of mouth in selecting particular games. Interestingly, negative press coverage for a game will significantly increase its adoption among younger players.

- People play games to escape from everyday life and to escape to a world of adventure which is without risk, and which, unlike the real world, is under the control of the gamer.

- Games provide a sense of achievement and are active, unlike television and films. However, games are better at developing action than building character, and as such, gamers tend to care less about the storyline than making progress in the game.

- Gamers appear to get distracted playing a game less readily than filmgoers watching a film because they have to participate in the game for it to proceed. However, while players appear to non-players to be engrossed in what they are doing, they are concentrating on making progress and are unlikely to be emotionally involved.

- Gamers claim that playing games is mentally stimulating and that it develops hand-eye coordination (BBFC, 2007, para. 1).

All of the above features are taken into consideration when a video game is being designed. According to Prensky:

> Video games design must have balance, which means that the game has to be fair; creative, meaning every new game has to provide something new; focused, to keep the player's attention; character, which must be identifiable

and penetrate the player's memory; tension, whereby there must be a goal and obstacles to overcome; and energy, physical and mental involvement and waste (Prensky 2000, pp. 133- 134).

3.6.ii Video Game Controversies

As video games have become a widely-used communication medium, particular issues such as violence and educational possibilities have emerged. Focus has been placed on the potential effects of these games, both good and bad. Funk and Buchman (1995) argue that although playing video games may constitute a positive activity for many children, the game playing conduct of some intense players may represent potential or existing social adaptation problems. In their research, adolescent girls who played several hours a week, and pre-adolescent boys who played a high proportion of violent games, had lower scores in particular areas of self-awareness.

Griffiths (1999) outlines the ongoing debate about the connection between video/computer games and violence. He confirms that based on a child's free play, the majority of his studies show that young children are more prone towards aggressive behaviour after an intensive violent video games session. Griffiths (1999) argues that this kind of empirical evidence veers towards a social learning theory of video games against a catharsis theory. According to the social learning theory, playing aggressive video games increases the risk of developing aggressive behaviour as children copy what they have seen on screen. Conversely, the catharsis theory asserts that playing violent video games has a positive, stabilising behavioural effect by providing an outlet for latent aggression.

Griffiths acknowledges that opinion remains divided as to whether the procedures developed to quantify aggression levels are reliable and valid.

According to Provenzo (1991), most findings reveal no supporting evidence that video game playing produces long-term aggressive behaviour. Instead, what has been found is that in the short-term, any activity (playing video games, television-viewing, or dart-throwing) when played in aggressive mode further increases the individual's inclination towards deviant behaviour (Silver & Williamson, 1987). Provenzo (1991) suggests that video game research should start by exploring how video games interact with other media, such as film and television.

Gross (1996) suggests that children derive more than just fun from intensive video game playing. He points out that particular motor and visual skills are improved by playing these games. Children process a large quantity of graphic and spatial data conveyed by the screen simultaneously. According to Gross, playing the game *Tetris*, which involves piecing together mental representations of external objects, has been proven to develop spatial skills in adolescents. In addition, he claims that video game playing enables children to adapt to technological innovations more easily, and indirectly encourages them to learn and explore the fields of science and technology.

However, Gross (1996) warns that excessive video game playing has been shown to actually reorder the neural structure of the user's brain. And while Gross takes the relatively benign view that these new neuronal structures may in fact develop certain skills, others are less charitable, believing that the psychological impact of continuous exposure to games with recurrent features of violence and slaughter can clearly be seen to be negative (Anderson, 2003). Since Nintendo's widespread penetration of the North

American market, sociologists have been vocal in their concerns about the casual ties between video games and violence. Hence Gross's (1996) conclusion, that no concrete evidence exists to suggest that video games drive children toward violent behaviour, has come under increasing challenge in recent years (Anderson, 2003; Olson et al., 2009).

Sherry (2001) found that when using meta-analysis (a statistical method that uses available studies to draw conclusions about a particular issue):

> there is a small effect of video game play on aggression, and the effect is smaller than the effect of violent television on aggression; within the range of games studied, the type of violence contained in the games is a predictor of aggression, with human and fantasy violence being associated with stronger effects than sports violence; and finally, there is a trend suggesting that longer playing times result in less aggression (Sherry, p. 425).

Indeed, Roy (2000) suggests that violence is not an independent variable but a combination of different factors. According to him, four categories encompass all human behaviour as described in the social science literature: intrapsychic, interpersonal, intragroup, and intergroup. As time goes by, and the individual experiences traumatic situations on one or any of these levels without the subsequent outlet of this trauma, a pool of anger can build up in him/her. In such cases, even the smallest event can trigger a violent reaction similar to the mass shootings that routinely occur in the United States. Olson (2009) indicates that, regrettably, no one as yet properly understands how these trigger situations develop.

Rather than asking ourselves if violent video games can affect an individual's behaviour, the question might rather be: why do individuals play violent video games and to what extent? In short, more research needs to be undertaken before any final conclusions can be reached regarding the connection between video games and violence. In the meantime, the gaming industry will in all likelihood continue to be an easy target for critics, especially given the recurrence of shootings in U.S. schoolyards involving students who appear to have been extensive video game users. However, such criticism has been counteracted to a certain extent by the integration of video games into education, which has flourished with the introduction of ludic tools in learning, as explained next.

3.7 DIGITAL GAME-BASED LEARNING

Prensky (2000) terms the marriage between video games and *learning digital game-based learning*. His thesis is that Generation X has a quantifiably different style of learning to previous generations. According to Prensky, digital game-based learning is attractive to Generation X because of: "The added engagement that comes from putting learning into the game context; especially for material people who loathe learning. The interactive learning process that is employed and which can take different forms depending on the learning goals. The ways the two are put together in the whole package" (p. 147).

3.8 Engagement

The concept of engagement in video games is fundamental to an understanding of why the marriage between learning and video games has been a successful one. Andresen and Ahdell (2001) describe six elements of engagement required to achieve learning results:

- Interactivity: After quoting different authors, Andresen and Ahdell (2001) conclude that interactivity plays a key role in the process of learning. The most memorable and "sticky" processes of instruction are those that present an interactive experience (Linder, 1999; Jones et al., 1994). Andresen and Ahdell (2001) explain that interactivity gives control to the user and provides the possibility of exploring the learning material at his/her own pace.

- Flexibility: Refers to the degree of control already provided by interactivity (Andresen & Ahdell, 2001). There is no general consensus about the degree of user control, as against computer control, required to make the learning experience more effective. Andresen & Ahdell (2001) have indicated that some users are more engaged if they have less control over the learning material provided by the computer, while for others it is the reverse.

- Dramatic effects: These include storytelling, music, sound, and so on. They provide the necessary hook to capture the user's attention. As in any media production, dramatic effects are the distinctive elements that appeal to the viewer and make them feel part of the story.

- Usability: According to Andresen and Ahdell (2001), researchers have determined that the product must not be difficult to use or play in order to keep the user engaged.

- Competition: Prensky (2007) explains that competition is what makes playing a game such an appealing activity. He indicates that to maintain levels of engagement, the user's skill must be balanced out by the degree of challenge and usability. The user must feel that a challenge exists that they can overcome.

- Reality: Andressen and Ahdell (2001) suggest that real-life elements may increase engagement. Reality can be complemented with dramatic effects to make the situation more engaging, as is the case with movies

3.9 Design and Learning Theories Within Digital Game-Based Learning

The interactive learning process has to reference design methods and learning theories (Quinn, 1997). Current learning theories have been described in previous pages. In relation to the design methods employed, Prensky (2000) argues that "good digital game-based learning does not favour either engagement or learning but strives to keep them both at a high level" (p. 150). In the process of designing digital game-based learning one of two paths can be followed: extrinsic games, where the game templates have nothing to do with the content of the learning material; or intrinsic games, where the content of the learning material forms the basis of the game (Fister, 1999). In addition, the learner can himself/herself be a creator or producer of the interactive learning experience (Hedberg, 1997).

Constructivist approaches tend to characterise the learner as a producer of the learning experience. Conversely, instructionist approaches tend to characterise the learner as the user of the software experience (Hedberg, 1997). Video games with an embedded learning content can accommodate both instructionist and constructivist approaches. The key lies in the concept of interactivity. In video games, the player is both a user and a producer. Each game a person plays follows the same format (instructionist view), but the play experience varies each time one plays (constructivist view), as each time the user constructs a slightly different action, puzzle, etc. The appropriate degree of balance between instructionist and constructivist content varies (Vichido et al., 2003). No one can definitively say which game design format is better (Pivec, 2007). Nonetheless, Prensky (2007) argues that in order to have a more prolific learning experience the learning material should be adapted into a video game format. This way, the user has the perception that he/she is really playing a video game.

3.10 Does Digital Game-Based Learning Really Work?

Recent research suggests that digital game-based learning does work (Prensky, 2007; Andresen & Ahdell, 2001; Pivec, 2007). Moreover, the use of interactive formats like video games as a medium to deliver knowledge is rapidly increasing. Kerievsky (2000) describes how the San Francisco company, Ninth House Network, is using interactive movies and games to deliver specific business skills to clients such as the U.S. Department of Justice and Hewlett Packard. She explains that Ninth House Network uses storytelling to engage the employees, or learners, allowing them to change the plot as part of the learning process.

Siglin (2000) provides an account of *Play Attention*, a high-tech learning tool that provides help to students with concentration problems. She describes how a computer-helmet device uses video games to maintain the user's attention. The student wears a helmet that translates brain output onto the computer screen as they interact with a video game. Siglin (2000) writes that according to *Play Attention* designer Peter Feer, its popularity among users comes from its use of a video game format.

MacPherson (1999) refers to the Corvallis CSO Project, an initiative launched in Corvallis, Oregon, U.S.A. CSO refers to Combined-Sewer Overflow and it occurs when there is heavy rain in the area. The U.S. government, through the Environmental Protection Agency, requires that local governments impose CSO controls in order to avoid bacterial outbreaks. The first step by the Corvallis city government was to develop public awareness of the problem through a communications strategy. In order to spread the message as effectively as possible they added interactive media to the more traditional media channels of leaflets, television, and radio. An information centre with interactive software was established in the Corvallis public library. Here, through the use of a video game format, the residents of Corvallis could access all the relevant information behind the CSO project as well as participating in a simulation. According to McPherson: “People learn best when they can visualize issues and concepts, participate in dialogue, and gain knowledge by interacting. As they can accommodate these needs, new media technologies -such as interactive computer programs and games, simulations, animations, videos, and the World Wide Web, are ideal tools for engaging..." (McPherson, 1999, p.1).

Greenwald (1999) discusses the *Fast for Word* video game software created by Scientific Learning, which is targeted at children with speech problems. The learning material enables students to process specific sounds of language following the principles of the plastic theory of the brain. This theory contends that the brain can be continuosly rewired throughout life. According to Greenwald, this is precisely what *Fast for Word* games claim to do.

The U.S. Marine Corp Institute provides training to almost 160,000 marines and delivers a variety of courses using an interactive multimedia learning environment. According to Garnett (1999), this learning environment “allows students to interact with instructional material of various levels of complexity, similar to computer simulations and games” (p. 2). In a similar vein, Lawlor (2001) describes how the US Naval Submarine School is using simulations to teach trainees everything involved in the daily operation of submarines.

Andresen and Ahdell (2001) conducted a case study involving three different digital game-based learning software products: *Business Challenge* developed by Involve Learning and Electrolux; *The Monkey Wrench Conspiracy* by Think3 and Games2Train

(G2T); and *Money-Maker* by Intermezzon. As they explain, these three products incorporate video game formats into specific learning material. *Business Challenge* is about adding company value, *Money-Maker* concerns sales, and *The Monkey Wrench Conspiracy* involves teaching engineers how to use a 3D design product called Think Design. Andresen and Ahdell's case study results lead them to the conclusion that while users tended to find video games and simulations more engaging than traditional training, further research was needed to measure the level of learning achieved. In some cases, they also found that games and simulations can help overcome boring e-learning content, depending on the user's preferences.

Nonetheless, as younger generations enter the labour market, the potential for video games and simulations as training tools will inevitably grow, commensurate with demands for greater interactivity and media richness. Gee (2007) puts the case for video game formats as the learning tools best equipped to foster innovation and creativity. He argues that players learn actively from playing video games, which require that they immerse themselves in the relevant knowledge so as to overcome the challenges the game poses. Gee suggests that if traditional educational institutions were to follow game design in developing curriculum, students would learn more effectively. In recent years, researchers have also tackled the importance of digital games in shaping cultural values (Gee, 2003; King & Borland, 2003; Poole, 2001), as well as their emergence as a leading new form of artistic expression (Jenkins, 2001).

Unsurprisingly, edutainment supporters believe that the future of digital game-based learning as a powerful new learning tool remains assured (Prensky, 2007; Thiagarajan, 2008). Indeed, social digital game-based learning games like *The Sims*, *Sim City*, *Age of*

Empires, *Railroad Tycoon*, and *Civilization*, already dominate the games market in terms of sales (Squire, 2002). *Sim City* and the *Sim City 3000* teacher's guide currently form part of social studies curricula throughout educational institutions in North America (Bradshaw, 2002; Teague & Teague, 1995). However, despite the financial success and ongoing interest of researchers and educators, there is as yet no consensus as to how video games can best be used as educational tools. In cases like *Sim City* or *Civilization*, while educators, companies, and education departments all advocate their use in classrooms, controversy remains about their effectiveness in school settings (Kolson, 1994; Lee, 1994; Teague & Teague, 1995). Questions about how teachers can use digital game-based learning and how students might actually learn through it, have started to capture the attention of academia (Berson, 1996; Hope, 1996 and Prensky, 2000). While some researchers argue that video games can be seen to foster collaboration and engagement in learning settings (Sandford, 2006), others have criticised digital game-based learning simulations by pointing to perceived distortions in their content.

In the case of *Sim City*, Kolson (1994) argues that it fails to acknowledge the importance of ethnicity and racial relations in the development of cities, that it has modified the job description of the City Mayor, and that it has minimized the significance of public transport to the average North American citizen (Figure 8).

Figure 8. Sim City

Civilization III has come under similar criticism from researchers and analysts. According to Barkin (2002), *Civilization III* incorporates German and French cultural theories that differ significantly from their Anglo-American counterparts.

The commercial nature of edutainment products, their instinct to put entertainment first and the classroom second, remains perhaps the greatest obstacle to both greater accuracy and reality, and their acceptance by the academic establishment. Nonetheless, the ever-growing number of edutainment users is enough to keep attracting the attention of researchers (Sandford, 2006). A game like *Civilization III*, created by Firaxis and published by Infogames in 2001, provides a framework for research into digital game-based learning and the study of world history (Squire, 2002).

The importance of accuracy in world history teaching activities has emerged as a matter of some urgency. As the saying goes, to understand the present one must first understand the past. World history is comprised of various academic perspectives, and can incorporate, elaborate, and enrich the various strands of regional or region-centric views of the past in the creation of a coherent, overarching historical tapestry. *Civilization III* is a digital game that includes accurate historical facts and allows the player to explore relationships between geography, politics, economics, and defense, across thousands of years and through multiple perspectives. The user leads a civilization from 4000 BC to present times, handling the civilization's natural resources, trade and finances, public and political policies, scientific research, and military (Figure 9). Digital game-based learning models, such as *Civilization III*, represent powerful learning instruments in which entertainment plays an important role. Educators and instructional designers need to study digital gaming learning structures and apply these features to educational game design (Games-to-Teach Team, 2003).

Figure 9. Civilization III

However, as the above review of the current literature on the subject demonstrates, there exists as yet relatively little research documenting the potential of digital games to support learning. Instead, one finds multiple examples of paper-based games and simulations used in the classroom (Clegg, 1991). Digital game-based learning will need to be properly acknowledged and documented as a learning tool, before it can make its way into the classroom (Becker, 2007).

The social context of game playing is also an important feature of the process of integrating learning and digital gaming. Chat rooms, newsgroups, e-mail conversations, social networking sites, and even social gatherings to discuss the features of a specific game, are potentially powerful tools to enhance learning. Educators will need to examine which learning tools are best able to promote thinking in students and then incorporate these tools into digital gaming environments. At the same time, they will need to explore game-student and student-student relationships (Becker, 2007).

As technology advances, this thesis proposes that digital game-based learning will become the future of educational formats. Different learning theories will be developed and each will have its own corresponding type of game. The following pages describe representative examples of digital game-based learning systems.

The Imparta Company, a UK software and simulations development company founded in 1998 and headed by Richard Barkey (visit www.imparta.com), has been developing successful simulations as training tools for companies worldwide. They employ advanced learning techniques and much of their success is due to the use of digital game-based formats. Most of their products are CD-ROM-based, but in recent years they have moved to online settings. It is important to study and analyse offline educational media like simulations or edutaiment CD-ROMs, for the reason that once the limitations of bandwidth are overcome, much of online learning design will adopt offline design features. Imparta develops business learning solutions in three specific areas: strategic decision-making, sales, and marketing. Imparta's clients worldwide include J. Walter Thompson, Abbey National, KPMG Consulting Group, and the Smith Group. Each product in these three areas has been the recipient of an international award, making the company a point of reference in the business simulations literature.

Imparta describes its software as combining "sophisticated computer game technology and artificial intelligence with leading-edge business content. The programmes have all been developed in conjunction with major international companies to assist managers in developing their business skills through an accelerated experience in a highly realistic setting that is supported by expert built-in coaching" (Imparta about us, 2003, para. 1). Imparta's leading digital game-based learning product is *Strategy Co-Pilot*. This product is aimed at building and reinforcing the skills required for business strategy. It was created in collaboration with INSEAD and the faculty of the London Business School.

Strategy Co-Pilot has three main sections: theory, simulation, and application. The theory section is made up of almost 50 tutorials. Each tutorial explores specific concepts relating to strategic business planning. The theory section is divided into six sections: Introduction, Diagnosis, Generating Ideas on Positioning, Generating Ideas on Advantage, Select and Refine, and Communicating the Strategy.

The introduction provides an overview of how to use *Strategy Co-pilot*. It discusses what strategy is, how strategic decisions are made, as well as the issue of problem-solving. The diagnosis section highlights the importance of identifying strategic plans and requirements. Generating ideas on positioning addresses questions such as: what position prevails, what positions can be identified, and which positions should be developed further? Similarly, the section generating ideas on advantage, addresses questions such as: how can the company develop its advantages, and can the company fight against competitive rivals? Select and refine deals with concepts linked to selecting a strategy, the strategic portfolio, planning the steps in the portfolio, and forecasting attitudes. Finally, when communicating the strategy there must be a list and a story to support the updated material in the presentation process.

Generally speaking, each tutorial has the same interface. The way the material is presented is similar to a tell-voiceover system (Prensky, 2007), although there are short flash cartoon-like animations. It is this author's experience, after running the theory tutorials twice that they have a penetrative effect on the minds of the audience, even though there are few ludic and interactive elements involved. Each tutorial also has its own set of exercises about a particular subject. These exercises provide good feedback in relation to the learning process and the material covered. The theory is necessary to further understand the simulation and application sections. The user can decide whether to start the theory or the simulation first.

The simulation has an introduction and four different phases. The introduction, as well as each phase, provides a real environment and application inside the theory section. The different theory phases and introduction match those of the simulation. The only difference is that phase five of the theory section is included in phase four of the simulation. That is, communicating the strategy goes inside the selecting and refining of the simulation, section. The precise logic behind *Strategy Co-Pilot* is to enable the theory, and a practical case-study for that specific theory, to be consulted interchangeably.

The interactive simulation process begins when the user selects the simulation window. The user is placed at a desk assuming the position of the person hired to fix ACME, a division of DUDE, the main company. ACME makes bottles and has been experiencing problems in its business recently. The user's job is to decide whether or not to buy ACME, in order to trump an offer made by another company. To support the job, the user is placed in a real environment with characters like DUDE´s CEO, Hunter Grove.

A floating toolbar to the right of the screen can be retrieved at anytime. This includes a to-do list, charts, data, and a slideshow. The purpose of the game is to give a presentation to Hunter Grove, DUDE´s CEO, explaining whether or not to sell ACME, based on the player's conclusions, and the information gathered while interacting with ACME's main characters: Lucia - Strategy Analyst, Phil Brave - Sales, Barry Berry - HR, Calum McPhall – CFO, and R. Wielder - Production. Furthermore, the user can design a strategy for ACME to become a better company. Interaction takes place among customers and additional characters, such as those in the design department. Each character interaction provides the user with hands-on experience on how to run a company team in a realistic atmosphere. The conversations and live video provide an immersive experience during the introduction and subsequent four phases. The ludic element is the simulation itself, the ability to impersonate a character.

A fundamental character in *Strategy Co-pilot* is the mentor, referred to by Imparta as Artifical Intelligent Coaching. The mentor is readily available whenever the user needs to ask something, and whose level of coaching in the simulation can be customised to a low, average, or high level. The mentor is based on Imparta's belief that learning by doing is an active experience in gaining skills, which can be improved upon if there is a coach or mentor to assist the learner in obtaining the best available skills and experience. In addition, every time a simulation phase is completed, a feedback form materialises which the user can use to correct their mistakes and look to for ways to improve their decisions. The third strategy of Co-Pilot's main section is application. This section comprises a series of templates and frameworks that work as hands-on assignments to examine the material learned in the preceding theory simulations.

Strategy Co-Pilot is a very appealing product and is currently in use worldwide (Imparta, 2008). Due to the advancement of broadband connectivity and faster Internet speeds, Imparta's production team has developed on online version. This version has certain limitations compared to the CD-ROM-based simulation. There are no real life characters and for marketing purposes it has been called *i-Coach*. *I-Coach* uses flash animations and it does not include a simulated scenario. The main difference between the online and offline versions is the gaming element. *I-Coach* displays the same content and tutorials as *Strategy Co-Pilot*, but without the interaction afforded by the simulation. This lack of interaction makes the online version more like an e-learning application. *I-Coach* could be regarded as e-Ludic learning if it embedded ludic features.

3.11 E-Ludic Learning Applications

Internet applications have simpler graphical interfaces due to slow connectivity, as has already been acknowledged in this thesis. The combination of the Internet and ludic learning applications has resulted in e-Ludic learning applications. Currently, there are a few companies developing e-Ludic learning sites on the Internet. However, there are few documented cases of academics or teachers using e-Ludic learning as instructional tools (Becker, 2007). As more people have access to broadband, more sites with interfaces similar to ludic learning applications will emerge. This section reviews some of the better representatives among the currently available e-Ludic learning sites.

3.11.i Funschool Website

Funschool.com (2004) is a private company created in 1996 in San Jose, California. The website is for children of all ages, from kindergarten through to the sixth grade. Funschool.com has more than 600 games with learning and play combined in an appealing and colourful interface (Figure 10).

Figure 10. Funschool homepage

The site can be browsed by children either independently or with their parents. While teachers can complement their school curriculum with some of the games, there is currently no official documentation of any actual school-based experience. Funschool receives approximately three million visits per month, with an average session time of 22 minutes (IAC Search and Media, 2007). The site allows for the searching of games based on academic grade level criteria (Figure 11). Most of the games are java-based and require a java-enabled browser. Each game is child-friendly and easy to follow, except when using a dial-up Internet connection, due to the time it takes to download (in the meantime tic-tac-toe can be played to avoid boredom). While no clear learning theory is identified, it is suggested that behavioural principles are used to create engagement (Funschool.com, 2007).

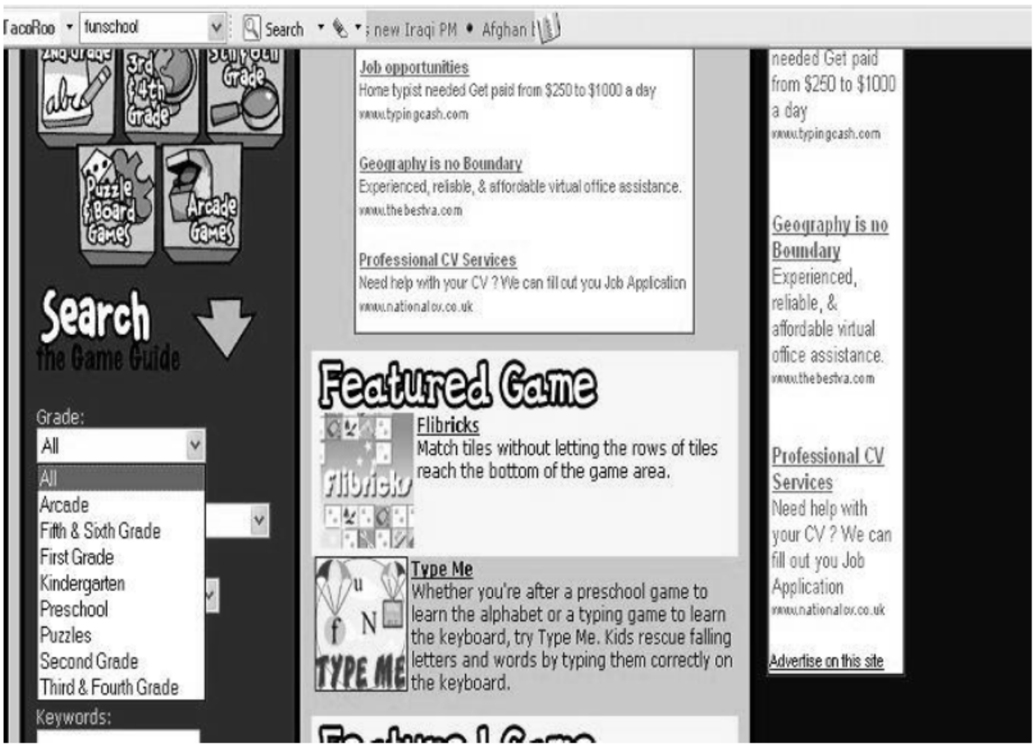


Figure 11. Funschool search option

Similarly, the funschool site makes no reference to the skills it considers itself to be developing. The games found in funschool.com include mathematics games, reading games, puzzles, board games, arcade games, and fun activities like printables. Feedback is given instantaneously, and the user can access tips in order to solve a particular task quickly. The site contains advertising, but it is related to content, and as a free site these advertisements are essential to the ongoing provision of content and services.

3.11.ii Funbrain Website

Funbrain.com is owned by the Family Education Network (Figure 12). The site claims 65,000 registered teachers and 35 million visits per month with almost 60,000 visits per day targeting K-8 students (Funbrain, 2005).

Figure 12. Funbrain homepage

While funbrain is not as colourful as funschool, it has a more of an educational structure. Teachers can review the curriculum and match the games to suit their students' needs. Funbrain focuses on mathematical education and reading skills. However, other subjects such as social sciences and music are included (Figure 13)

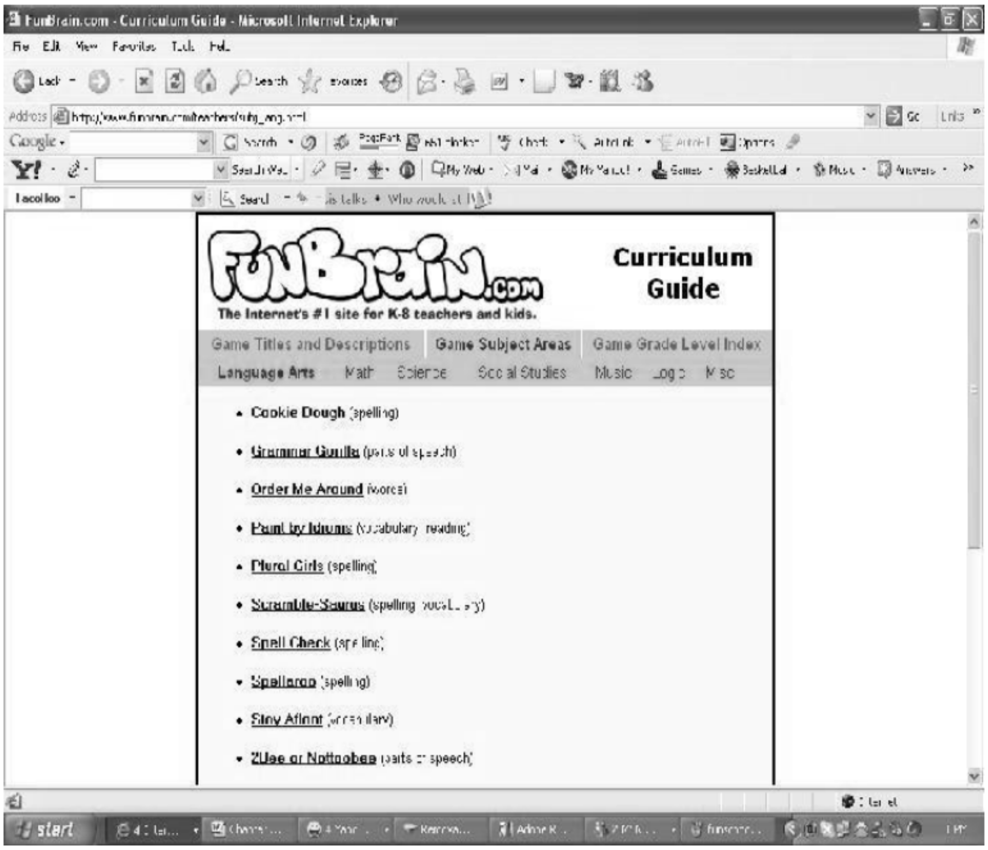


Figure 13. Funbrain curriculum alternatives

While there is no clear description of the learning theory involved in each game, there is an indication of achievable skills. Game instructions are clear and at the same time parents and teachers can chart results. Funbrain has fewer advertisements than funschool, and the focus of the advertising is on education.

3.11.iii Primary Games Website

Primarygames.com (2005) is part of the School Sites Network. It targets K-4 students with the content arranged in subject areas. It offers maths, science, languages, art, social studies, and miscellaneous content (Figure 14).

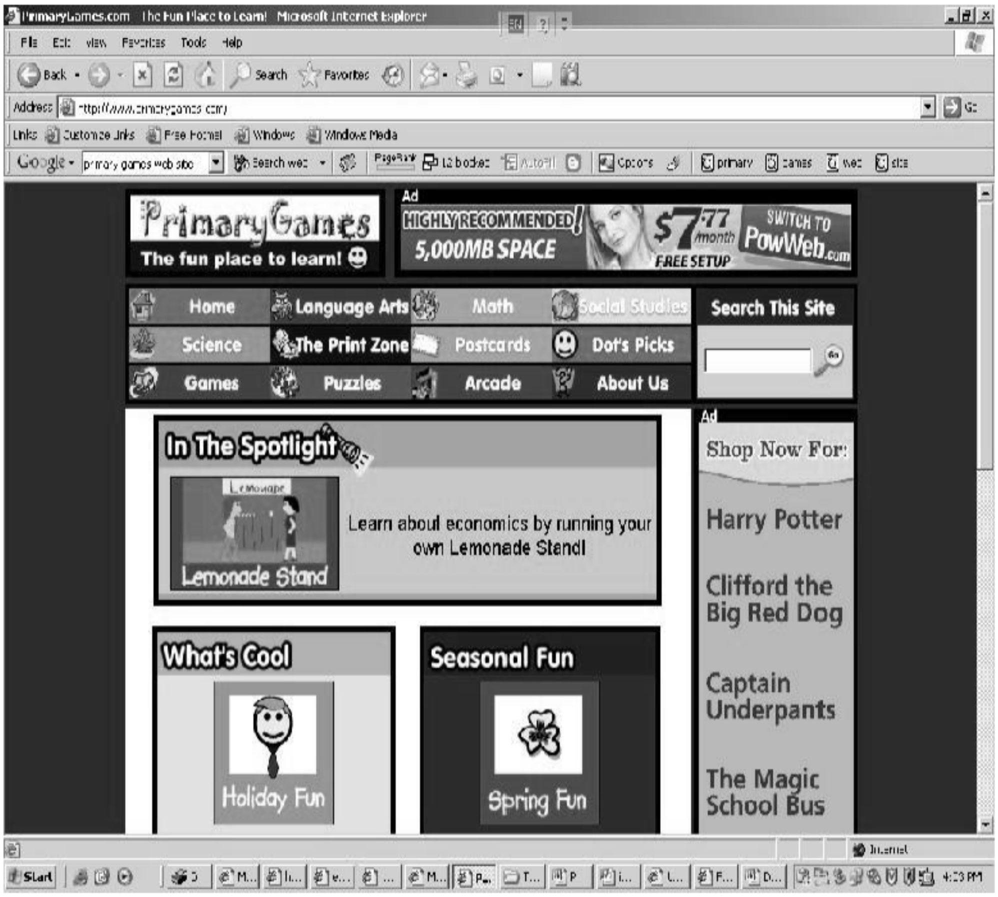


Figure 14. Primary Games homepage

The games are aimed at developing different skills. Language skill activities include ABCs, alphabetic order, and reading; math skills involve money counting, addition, and subtraction; science relates to seasons and plants; and the social sciences teach students about holidays (Figure 15).

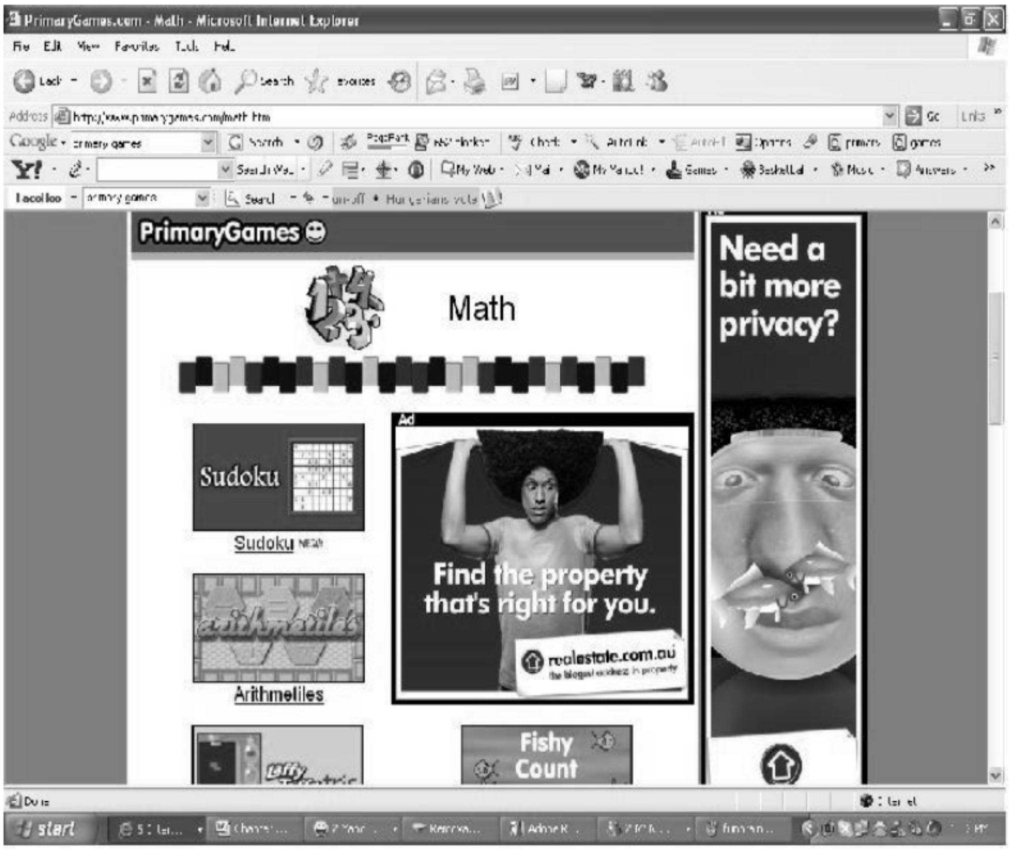


Figure 15. Primary Games interface

Primarygames.com contains more advertisements than the previous websites which may concern some parents and teachers. Access is free, however.

3.11.iv Other Applications

Primarygames.com, funschool.com, and funbrain.com are not the only e-Ludic learning applications available online. Another 28 e-Ludic learning sites were found using Google and Yahoo search engines. The majority of the sites were in English, with a few in Spanish. However, these were essentially translations from their American counterparts.

Most e-Ludic learning applications have been developed in industrialised economies, targeting their own populations. The interface design is familiar to industrialised Generation X-users. Nonetheless, as demonstrated in this research, there is little difference in design features for users in low-ICT aware areas. The major obstacles to e-Ludic learning in these regions are accessibility and infrastructure. The next chapter deals with low-ICT aware areas and worldwide action to tackle the digital divide. Next I describe how this chapter contributes to the e-Ludic learning model proposed in Chapter Two.

3.12 THE EVOLUTION OF THE MODEL

Figure 8 back in Chapter Two provided a theoretical conceptualisation for e-Ludic learning. The practical references in this chapter, Chapter Three, are now incorporated into figure 8 to deliver the more comprehensive e-Ludic learning model of figure 16.

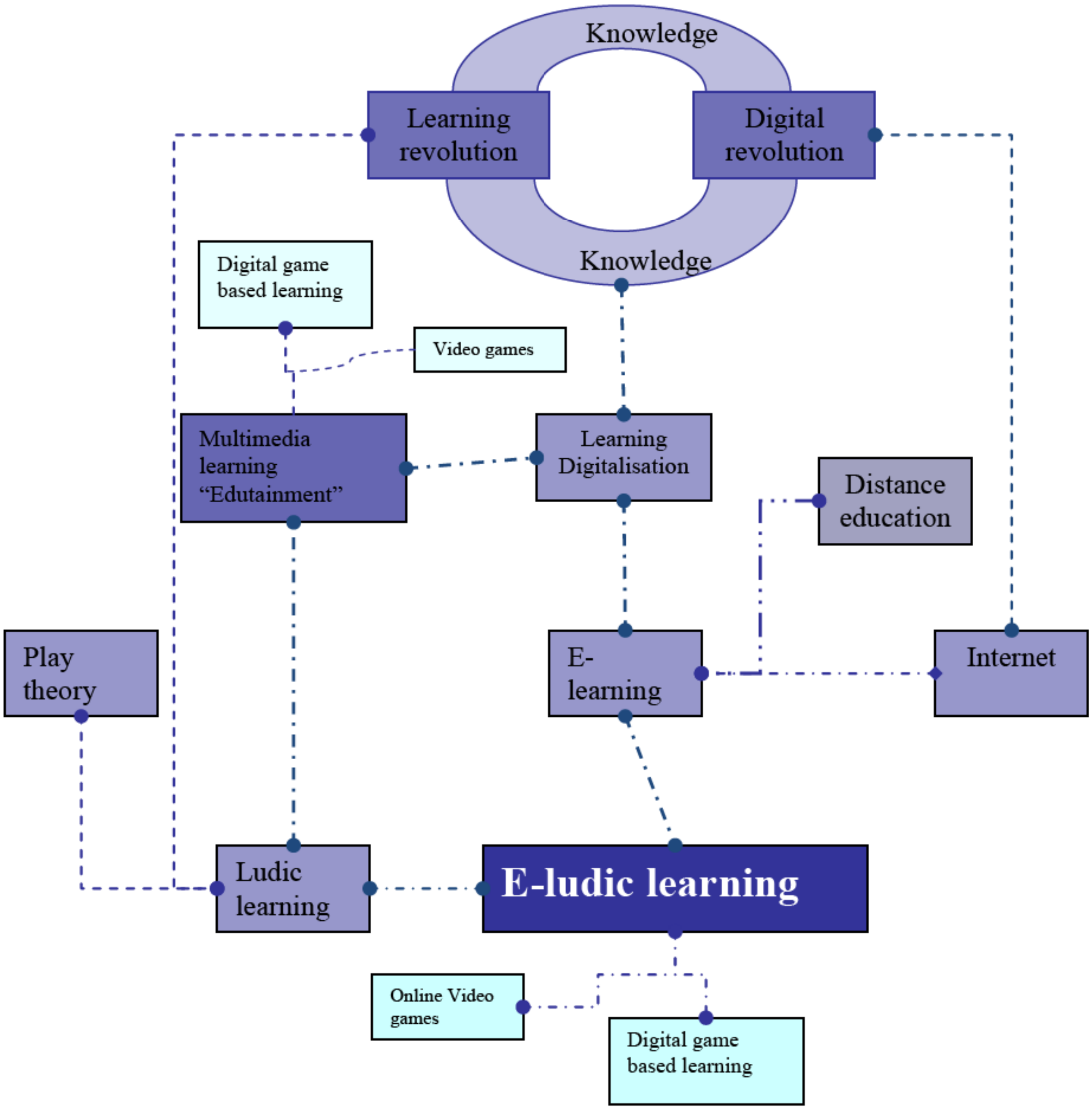


Figure 16. E-Ludic learning model evolution

The augmented model above outlines the evolutionary process that has led to e-Ludic learning. The intersection of the Learning and Digital Revolutions has resulted in learning digitalisation; learning content in digital formats. Initially it was CD-ROMs. Then, with the advent of the Internet, it became e-learning. E-learning adopted some of the features and methodologies of traditional distance education (Faulkner, 2005). Simultaneously, new developments in learning theories and the incorporation of play as an engagement tool, led to the advancement of ludic learning. The digitalisation of ludic learning gave birth to multimedia applications in the form of edutainment, which provided interactive learning environments, as in the case of *Sesame Street Adventures* and *Sim City*. These applications adopted the Internet as a more powerful communication channel, and subsequent e-Ludic learning products emerged like *Funschool* and *Funbrain*.

In recent years, ludic worlds have evolved into more sophisticated applications like video games. CD-ROM-based games and online games are presently used as learning tools in digital game-based learning formats (Prensky, 2007). As figure 18 indicates, online digital game-based learning is a subset of e-Ludic learning. The common thread of both formats is ludic learning. This model is reviewed in the next chapter, in relation to an analysis of low ICT-aware regions.

CHAPTER IV: LOW ICT-AWARE REGIONS AND DIGITAL PUEBLA

4.1 ICT-AWARE REGIONS

Awareness of ICT has evolved, and subsequently it has taken on a host of different denominations. Terms such as e-digital, e-literacy, and e-awareness usually refer to ICT-awareness. For the purposes of this research, ICT-awareness refers to the degree of ICT penetration and ICT knowledge within a particular community. ICT penetration relates to hardware and infrastructure. ICT knowledge is the degree of understanding that the user has in relation to digital content or software. I have created an instrument to measure ICT-awareness in primary students in a Low ICT-aware region (Appendix 8). ICT-awareness varies depending on regional infrastructure, levels of computer penetration, and software application. Global development organisations have different ways of measuring ICT-awareness. UNESCO, ONU, OECD, and the World Bank, acknowledge three basic levels of ICT-awareness: high, medium, and low. The importance of ICT for development is well-documented, and in the context of Latin America, there is an existing body of research in the field.

4.2 THE IMPORTANCE OF ICT-AWARENESS FOR DEVELOPMENT

ICT is a powerful tool for development, and countries that embrace this technology quickly and extensively will be best placed to succeed in the Information Age. Hilbert (2001) identifies five areas in the process of ICT integration in Latin America: access, regulatory framework, financing, education, and what he terms e-awareness. He argues that new conditions have emerged as a result of the development of ICT. Hilbert's main argument is that countries that are early-adopters of ICT will benefit more than late-adopters. He characterises Latin America as a historical latecomer in general. However, in the case of the ICT revolution, he argues that Latin America has no excuse for failing to join in as quickly as possible.

According to Hilbert, Latin America enjoys particular advantages that should promote the diffusion of ICT. Fundamental to these advantages are a common language and common customs throughout the region. Hilbert regards Latin America as one of the fastest-growing regions in relation to Internet connectivity. He argues that Latin America is among those regions that understand the benefits and importance of ICT, but are passive in their usage. In addition to such passive consumers of digital technology, Hilbert indentifies two other types of regions: those that are using the tools of ICT actively to produce digital goods, and those regions that have yet to embrace the benefits of ICT.

A basic challenge for the development of ICT in Latin America is what Hilbert refers to as e-infrastructure. The infrastructure involved in ICT is telecommunications, and unless better and more cost-effective telecommunications services (e.g Telmex in Mexico) are provided in Latin America, the spread of ICT will continue slowly. For Hilbert, the key lies in competition. Governments will need to actively encourage competition among telecommunication service providers so as to ensure the development of the required digital infrastructure (Mariscal, Bonina & Luna, 2007). At the same time, the region must focus on alternative means of accessing the Internet. Hilbert explains that while Latin America might not enjoy a high level of fixed-line telephone penetration, if we consider 2G and 3G mobile communication, themselves a kind of digital network, most of the region is already covered. The crucial point therefore, is to develop policies that explore economically viable alternatives to traditional infrastructure (Mariscal, Bonina & Luna, 2007). Latin America is at a stage where, with the guidance of good public policy, it can catch up with more advanced societies (Barrantes, 2007). It can be argued that national or regional development need not be linear, and that more than ever before, the possibility exists of a technological leapfrog.

Proenza (2002) introduces the concept e-For-All as a set of public guidelines for the strategic application of ICT to combat and tackle poverty. E-For-All encompasses three scenarios:

- Scenario One: New ICT must help low-income people achieve a better standard of living. This is possible because ICT improvement reduces the costs of servicing marginalised communities, and these savings can go to generating social capital instead.
- Scenario Two: Public policy must deliver ICT services and benefits to every member of society and must promote business activity. Poor people must be included in specific plans to increase their incomes and must be involved in the decision-making process.

- Scenario Three: Government must finance ICT development as a tool to combat and reduce poverty.

Nevertheless, in the context of a developing country, government funding requires specific and clear information about cost, impact, and effectiveness before any decision is taken. ICT initiatives to tackle poverty must acknowledge and be applicable to the low-productivity setting in which they are to be implemented, and any additional support must consider cost as a fundamental variable to achieve sustainability.

Proenza (2002) proposes a series of elements that must integrate public policy regarding ICT implementation (Table 4). The framework extends to the notion of e-readiness described by Hilbert (2001). This measurement considers two factors; one being the general business environment and the other being connectivity. Mexico ranked 34 in e-Readiness worldwide (e-readiness, 2006).

Table 4. E-For-All policy guidelines

Widespread access to networks	Refers to policies implemented by the government to make ICT use cost-effectiveness in rural areas and provide e-awareness solutions.
Democratic Networked Learning	The government must provide the right infrastructure for ICT accessibility in State schools.
Networked competitive development for all	Are rural workers and companies integrated into ICT?
Networked social development	Development of policies to allow the poor access to ICT.
ICT and poverty in national development policy	ICT must be incorporated as part of a national poverty reduction policy.

Note (adapted from Proenza 2002)

Digital Puebla applied the E-For-All policy guide to deliver Internet all over the state of Puebla, and to isolated rural populations in particular. Every element of Proenza's proposal has been used as a reference point for the implementation of Digital Puebla, as explained later in this chapter.

Huggins and Izushi (2002) argue that the obstacle faced by isolated rural populations is the lack of opportunity to access new technologies and peer learning-based innovations. This lack of access results in low ICT-awareness, which in turn leads to a comparatively slow business environment. Huggins and Izushi (2002) recommend setting up community centres with free Internet access, providing incentives for Internet cafe openings, facilitating the private ownership of local Internet service providers, and providing financial support for local management training. Community participation is essential to the early adoption of ICT technologies. Nonetheless, the process of adoption should not take place from a purely technologically deterministic point of view. Communities do not assimilate technology merely for the fact that it is an innovative tool. There needs to be a process of social construction regarding the use of ICT. Social construction involves the assimilation of an innovation. Innovations are diffused at different rates depending on factors relating to local circumstances.

4.3 ICT as Innovation: Diffusion of Innovations Model

According to Rogers: "Diffusion is the process by which (1) an innovation (2) is communicated through certain channels (3) over time (4) among the members of a social system. Diffusion is a special type of communication concerned with the spread of messages that are perceived as new ideas" (Rogers, 1995, p. 5).

4.3.i The Mechanism of Diffusion

Every individual goes through the same mechanism of diffusion for any stage. The five-step sequential process is as follows:

- Knowledge - the individual understands the innovation.
- Persuasion - the individual develops a positive or negative opinion regarding the innovation.
- Decision - the individual adopts or rejects the innovation.

- Implementation - the individual uses the innovation.
- Confirmation - the individual validates the innovation.

The mechanism of diffusion is an internal process which is influenced by a social network. ICT is perceived as an innovation in areas where the awareness of ICT is low. The Digital Puebla program has targeted early adopters in different Low ICT- aware areas throughout the state of Puebla, Mexico, in recognition of the fact that early adoption of ICT will lead to substantial benefits for the region. Indeed, ICT adoption provides not only the prospect of progress, it also provides the real potential of achieving a technological leapfrog.

4.4 TECHNOLOGICAL LEAPFROG

Hilbert (2001) indicates that a technological leapfrog is a catch-up process between countries with less, and countries with more, technological development. These days it is a common contention that modern economies have moved from being industrial-based to being digital-based (Rahman, 2006). This shift has enabled knowledge-oriented work to replace the production-oriented work of the industrial era (Stone, 2009).

Before the digital era, progress was linear in form (Hilbert, 2001). Traditional economic theory is informed by the scarcity principle, and the principles of the optimisation of physical labour and financial capital. Scarcity constitutes the notion that the means of production can be used up. However, in the case of knowledge, which can constantly be generated and improved, this notion of scarcity simply does not apply.

Accordingly, Hilbert's technological leapfrog argument (2001) is that pre-industrialised nations need only invest in, and generate, knowledge, in order to achieve digital status, rather than having to expend resources in order to achieve industrial status before going digital.

Importantly, the cost of ICT infrastructure is much less than the cost of industrial infrastructure. Imitation and reproduction are far easier with ICT, particularly with Internet technologies, whereby knowledge can be accessed anywhere/anytime (Katz, 2002). It therefore incumbent upon governments to invest resources in the provision of Internet access, and to promote the smart and suitable use of what Hilbert (2001) refers to as the *Great Equalizer*. At the outset, government policy needs to acknowledge ICT as an innovation whose diffusion is subject to the inter-networking of the social system it is intended to penetrate. Roger's diffusion of innovations theory applies to ICT and Internet assimilation. A low ITC–aware setting provides the opportunity to experiment with the use of ICT tools. There is not an exact correlation between low-ICT regions and poor economic development, as some countries with vast natural resources have low digital indexes. Nonetheless, most countries with higher economic standards tend to enjoy higher ICT awareness (Hilbert, 2001).

Currently, there are multiple initiatives supported by governments and private organisations to bring ICT use and the Internet to low ICT-aware regions worldwide. Their success has been documented in different forms, as explained below.

4.5 Worldwide Initiatives to Increase ICT-Awareness

4.5.i UNESCO - Information For All Programme (IFAP)

The UNESCO flagship program, IFAP, is designed to promote access to information technologies and to maintain the flow of ideas through media. It encourages cooperation among nations to share information and transfer technologies. The main objective of the *Information for All Programme* is to diminish the digital divide between those that have information access and those that lack digital infraestructure. In so doing, IFAP provides a framework to participating nations for networking and cooperation in the quest for common solutions to the implementation of ICT. According to the UNESCO website dedicated to the program, the specific goals are:

- To promote international reflection and debate on the ethical, legal, and societal challenges of the information society.
- To promote and widen access to information in the public domain through the organisation, digitisation, and preservation of information.
- To support training, continuing education and lifelong-learning in the fields of communication, information, and informatics.
- To support the production of local content and foster the availability of indigenous knowledge through basic literacy and ICT literacy training.
- To promote the use of international standards and best practices in communication, information, and informatics in UNESCO's fields of competence.

- To promote information and knowledge networking at local, national, regional, and international levels (UNESCO, IFAP, 2005, para. 3).

In addition, IFAP features five areas of development:

- Area one establishes a common framework for considering information access as a basic human right. Area one's concerns include common policies involving the exchange of information, with particular emphasis on ICT and the Internet.

- Area two focuses on the development of ICT literacy and the creation of networks between information specialists. The goal here is to foster ICT training through international networks.

- Area three aims to strengthen information access gateways through the promotion of the UNESCO portal, for those institutions or projects involved in ICT development worldwide.

- Area four studies the best practices in information management worldwide. All research is published so that it can be readily accessed by anyone worldwide.

- Area five aims to promote ICT for education, science, culture, and communication. The actions taken in this area have included the establishment of a monitoring system for ICT trends and uses, the creation of UNESCO's portal with links to worldwide research institutions and universities, and the expansion of information-sharing networks.

The success of IFAP depends upon the collaboration and information-sharing of participating members. UNESCO's mission is to promote educational development. An evaluation of UNESCO's program is conducted every year with the results published in its portal. A council of 26 member states guide the planning and implementation of the Information For All Programme.

4.5.ii UN - Information and Communication Technologies for Development (ICTD)

The United Nations Development Programme (UNDP) is the United Nation's global development network. It aims to foster knowledge-sharing between countries. This program operates in 166 countries, working with local governments and within their particular initiatives. When local governments cooperate with the UNDP they gain access to all the programs, global contacts, and partnerships that UNDP has to offer. One of the main activities of the UNDP is to coordinate national and local efforts to reach the Millennium Development Goals targeted for 2015 (UNDP, 2005). UNDP has different initiatives to help countries overcome poverty. The Information and Communication Technologies for Development (ICTD) is UNDP's leading initiative for ICT. The UN has acknowledged the importance of ICT as a development tool since 1992. The ICTD program has gained expertise and experience from a variety of global initiatives, such as the Sustainable Development Networking Programme (SDNP), the Small Islands Developing States Network (SIDSNet), and the Cisco-UNDP Network Academies Programme for 24 LDCs. Likewise, ICTD has profited from an exchange with regional initiatives, such as the Asia Pacific Development Internet Programme (APDIP) and the Internet Initiative for Africa (IIA), as well as national programs, such as Ukraine's FreeNet, Egypt's Community Access Centres, and Cameroon's SchoolNets, to name just a few. ICTD promotes ICT as a key tool to combat poverty worldwide. The function of the program is to advise nations in the use of ICT as an innovation, and to promote knowledge, and consequently development, in poor regions. ICTD has five strategic areas of intervention:

- National ICT development strategies
- Capacity development through strategy implementation
- E-governance to promote citizen participation and government transparency
- Bottom-up ICTD initiatives to support civil society and Small and Medium Enterprises (SMEs)
- National awareness and stakeholder campaigns (UNDP, About ICTD, 2005, para. 5)

Supported by international donations and contributions, ICTD finances new initiatives in almost 25 countries, amounting to almost seven million U.S. dollars.

4.5.iii Educational Portal of the Americas (ECLAC)

The Organisation of American States (OAS) has as its goal the development and progress of the American region (OAS Educational portal, 2005). One of the main projects within OAS is the Inter-American Agency for Cooperation and Development (IAACD), whose role is to bring greater ICT access to the region through training and educational initiatives. Currently, IAACD's main initiative is the Educational Portal of the Americas, the aim of which is to foster new educational methods through the use of distance and e–learning formats. Groups targeted by the portal include rural and remote communities, where distance education has been found to be the solution to most of the problems faced by these communities. OAS has indicated in several forums that the portal's goal is to achieve a more democratic and educated American continent.

The Educational Portal of the Americas currently has a fellowship program which supports various forms of research related to the use of ICT as a tool against poverty (OAS Educational portal, 2005). In addition, there are over 4,000 links to distance education courses for the ongoing development of teachers and other professionals.

4.5.iv Digital Divide Network

The Digital Divide Network (DDN) was established in 1999 as a result of the National Digital Divide Summit supported by then U.S. President Bill Clinton (DDN, 2005). Its objective is to provide a clearing-house for resources related to the digital divide. DDN is an interactive on-line community aimed at helping digital proposals reach different audiences, with the aim of eradicating the digital divide. DDN provides free access to blogging, research articles, discussion boards, and other instruments concerning the implementation of e-technologies. It also hosts *Digital Divide*, the world's largest e-mail discussion group about digital divide issues (DDN, 2005).

4.5.v Alliance for the Information Society (LIS)

The goal of LIS is to foster cooperation between European and Latin-American members. It involves the following five targets:

- To facilitate the integration of Latin-American countries into the global information society.
- To promote dialogue between the various stakeholders of the information society.
- To increase the interconnection between the research and development communities of both regions.
- To meet the needs of local communities and citizens as part of sustainable development.
- To implement innovative applications that can be easily replicated, such as computer programs, the installation of material, or the establishment of networks (LIS, 2005, para. 1).

4.5.vi Bridges.org

Bridges.org is an international organisation that seeks to use ICT in the Third World to tackle poverty and improve living standards. It researches the factors hindering the spread and implementation of ICT in poor regions, and develops solutions to improve the socio-economic landscape of these regions (Bridges.org, 2005). Bridges.org works with local governments to create e-government solutions and policy documents for the proper implementation of ICT solutions. It strives to bring early adopters and innovators together with the rest of the population in disadvantaged regions, so as to discuss ICT diffusion and the implications and benefits of technology use. Bridges.org's areas of expertise have been in healthcare, education, indigenous economic development, environmental protection, food resources management, and water and energy. Its main activity has been in the sponsoring of workshops, research activities, and on-line access to multiple databases (Bridges.org, 2005).

4.5.vii E-Government for Development

The e-Government for Development website is an initiative to assist the governments of developing countries in formulating their own e-government solutions. It is a free site with a step-by-step tutorial on how to implement an e-government website. It covers all the elements required in a web project, from the planning and implementation phase to the evaluation and maintenance stage. While the site provides technical advice, it focuses more on management and implementation, so that governments in developing countries can get free expert advice from the best practitioners worldwide (e-Government, 2005).

4.5.viii Learnlink Digital Tools for Development

Learnlink was implemented between 1996 and 2003 with funds from the United States Agency for International Development (USAID), through the Academy for Educational Development. It established almost 20 ICT- based activities worldwide to support economic and social development. Seventeen countries participated, with activities in teacher training, professional development, e-learning, life-long learning, local e-governments solutions, and institutional strengthening. Currently, anyone can access accounts of the success stories that resulted from this effort on the Internet (Learnlink, 2005).

4.6 Country Cases

Different countries around the world are implementing their own local solutions to overcome the digital divide and to spread the use of ICT as a development tool. I conducted a literature review of the most relevant cases and came across two of the most awarded programs: the Finland Upper Karelia project and the Indian Akshaya Project.

4.6.i Finland-Learning Upper Karelia Project

According to Oksa and Turunen: "Learning Upper Karelia is a rural and local information society project seeking to achieve social objectives: preventing social exclusion, supporting social innovations, improving services and living conditions" (Oksa & Turunen, 2002, p. 6). The Upper Karelia project started as a result of a meeting in the region relating to the closure of an agricultural school for farmers. While the institution was closed, the idea of having an information society instrument emerged as a result. The project started in 1998 when 21 unemployed volunteers were trained in ICT use. Finances for the Upper Karelia Project came from the Finnish National Fund for Research and Development (SITRA). The Upper Karelia project was subsequently responsible for training inhabitants of the region in the creation of a training network. Initially they had one computer kiosk. This figure grew to 30 the following year, when users were granted free Internet access. While at first web surfing was the main activity, training in ICT use soon became the principal focus. Indeed, a group of 15 of the 21 unemployed individuals initially trained went on to create their own training company "Karelian Netfellows Ltd". Through Upper Karelia's success, Finnish authorities demonstrated that ICT use and implementation bring positive results not only to local communities, but to the social system as a whole (small-town networks, 2002).

4.6.ii India-Akshaya Project

The Akshaya project has been implemented by the Kerala regional government in India. The Kerala region has the highest literary and technology index in India, but it also has the lowest ICT penetration in its rural areas, making it the ideal candidate for a digital divide solution. The Akshaya philosophy is to provide universal Internet access to the inhabitants of Kerala's rural regions, in order to develop skill sets and online content for e-business and economic development. The Akshaya Project objectives are:

- To develop over 6,000 members of networked Multi-purpose Community Information Centres (Akshaya Centres) so as to provide ICT access to the entire population of the state.
- To make at least one member in each of the 65 Lakh families IT literate.
- To enhance the quality of available IT infrastructure in the state.
- To extend IT infrastructure to the rural parts of the state.

- To accelerate the development of local content relevant to the population (Akshaya project, 2005, para. 1).

Akshaya's implementation is expected to:

- Create and expand economic opportunities in the knowledge economy.
- Empower individuals and communities through enhanced access to information.
- Modernise and upgrade skill sets.
- Integrate communities through the creation of e-networks.
- Create an awareness of ICT tools and usage.
- Generate content that is relevant and useful to the common people.
- Generate content in the local language.
- Generate over 50,000 employment opportunities in three years.
- Generate direct investment of over Rs. 500 crores (approx 100 million USD) in 3 years (Akshaya Project Objectives, 2005, para. 3).

To date, Akshaya results have been remarkable, according to Indian authorities (Akshaya Project News, 2008). The first step was the establishment of Internet access hubs called Akshaya e-Centres throughout the State of Kerala. The Centres have following specific characteristics:

- A centre within 2km of every household for a total of 9,000 centres.
- Each centre to cater to an average of 1,000 families.
- All centres internetworked through the Internet.

- Created and run by entrepreneurs.
- Manned by trained personnel.
- Support facilities like web-cams, scanners, printers, fax machines, etc. (Akshaya Project Objectives, 2005, para. 4).

Skillset development in the Akshaya Project is focused on creating a one-hundred percent e-literate state. To this end it has provided computers, training in e-learning modules covering basic computer applications, spoken English training, multimedia training, and more. The increased ICT literacy of Kerala's inhabitants is bringing positive results. Akshaya's vision has been recognised internationally, and the model is now copied in different parts of the world (Akshaya Project News, 2008).

The above two projects have succeeded in reaching their goals because the respective governments have understood the benefits of ICT to their populations. At the same time, the local populations have acknowledged, through peer-to-peer and other communications media, that ICT adoption is beneficial to them. The process of diffusion has taken place at an amazingly rapid rate in both cases. Indeed, most communities in rural and low ICT-aware areas where ICT solutions have been implemented have shown impressive rates of adoption (Unesco Observatory on Information Society, 2005).

However, ICT implementation is not the only public policy means to achieve economic development. Hilbert (2001) argues that other policies need to be implemented as well. Local and national governments have to open their markets to foreign investment, enforce property rights protection, and provide education to all their citizens. Education must not only be comprehensive and inclusive of every citizen, it also needs to be of a high standard. Unfortunately, Latin American educational standards lag behind those of other countries with similar economic levels. This means that more investment has to be directed towards education, with accountability in the form of permanent reporting on quality performance. At the same time, the use of ICT can itself increase the quality of education. Thus, governments have at their disposal a two-way developmental strategy whereby education and ICT complement each other as development tools.

Infrastructure is another area of concern for ICT implementation. In most cases, the local public and private sectors can barely cover the cost of setting up ICT infrastructure. Nonetheless, as indicated earlier, the cost of establishing ICT infrastructure remains a fraction of the cost of building industrial infrastructure. Ultimately, it will prove highly cost-effective for public spending to be allocated to developing an ICT knowledge-based economy rather than an industrial-based economy.

Any solution aiming to diffuse ICT as a development tool has to identify early adopters in the social setting it targets. Then, a suitable communication channel to promote the benefits of ICT must be selected. Traditionally, the way to reach out to early adopters has been through mass media mediums such as television, radio, or print advertising. Once a mass media campaign has been launched, governments then have to approach opinion leaders in the region. Nonetheless, Rogers (1995) indicates that peer-to-peer communication remains the most effective form of communication in the diffusion of an innovation. With the Digital Revolution, the Internet has emerged as *the* medium for instantaneous peer-to-peer communication. Governments need to acknowledge the advantage of the Internet relative to traditional media instruments, and explain why the Internet is compatible with the needs of the population. Early adopters need to be shown that Internet use is neither complex, nor something that requires extensive computer or information system skills. In order to achieve this, development agencies will need to conduct Internet workshops among communities of early adopters, so as to provide an understanding both of computer use, and the importance of this use, to their daily lives. Once early adopters have accepted this technology, they then have to be encouraged to persuade the general population of its merits.

It is vitally important that governments understand the nature of the social system. Rogers (1995) writes that there are two types of social systems: heterophilous and homophilous. A heterophilous social system is a system where there is more interaction among individuals from different backgrounds. In this system members tend to be comfortable with, and promote, change from social norms. The homophilous system observes less interaction among individuals from different backgrounds. Consequently, they tend to stick to social norms. Diffusion of an innovation is therefore more difficult in a homophilous system. A correct understanding of social setting will prove invaluable in deciding upon the most appropriate mass media strategy. There are a number of alternatives in establishing ICT infrastructure, as outlined above. The project addressed by this thesis is Digital Puebla, and operates through the Communication and Information State System (SICOM) in the State of Puebla, Mexico. The following sections describe the project, the conceptualisation of which has been based on successful practices in other areas.

4.7 THE MEXICAN ICT ENVIRONMENT

Mexico has a medium-developed economy, and is considered both an emerging market and an emerging democracy. In the past 15 years, Mexico has decided to reverse the decades-long tradition of heavy state control of the economy. The federal government has privatised and liberalised most state-owned industries, including the valuable telecommunications industry. It has realised that from a short, medium, and long-term perspective, advancement in ICT is essential to better economic performance at an international level, and for a fairer distribution of income domestically. The federal government, as well as most state governments, understand that knowledge and ICT investment is the opportunity to reduce not only the digital gap that prevails in the country, but also the economic disparities that affect the whole region (Garrido, 2005).

The government's first step has been to establish a market-oriented economy, contrary to the nationalistic philosophy that prevailed in the 1970s and 1980s, which made the Mexican economy less competitive. In addition, at the political level, the country is currently experiencing a democratic change with the Presidency now occupied by the National Action Party (PAN). This comes after almost 70 years of absolute rule by the Institutional Revolutionary Party (PRI), in which corruption, lack of transparency, and lack of efficiency became national concerns. Nonetheless, it was the PRI that established the platform for the liberalisation of the Mexican economy that occurred under Carlos Salinas's and Ernesto Zedillo's presidential terms. Under PAN leader Vicente Fox's presidency, the international perception of the Mexico is that of a progressive democracy.

Under the Salinas and Zedillo presidencies, Mexico became a member of the World Trade Organization (WTO) and signed on to the North American Free Trade Agreement

(NAFTA). Both treaties acknowledge the importance of ICT for the development of the Mexican economy. In regards to NAFTA, the Mexican government signed multiple cooperation agreements with its North American counterparts. Canada and the U.S. have indicated to the Mexican government that in their eyes ICT implementation not only represents economic progress, it also represents greater freedom of speech, freedom of the press, and intellectual rights protection. The latter has been a particular concern of Canadian and U.S. authorities. Perhaps the greatest challenge for the Mexican government in obtaining ICT investment is to provide a robust and transparent legal framework, in which the ICT industry can trust the authorities regarding property rights (Bustos, et al., 2005).

4.8 IT Strengths and Weaknesses in Mexico

Mexico is well-positioned to participate in the ICT revolution. It currently enjoys a high-volume information exchange with the U.S., and the implementation of NAFTA between Mexico, Canada, and the United States, has provided it with a powerful competitive tool. NAFTA has provided Mexico with lower tariffs for both exports and imports within the region. Likewise, capital investment is less restricted, meaning that North American investors gain better returns from investing in Mexico than in other countries. ICT investment in Mexico has been increasing steadily each year for the past decade, with much of the investment flowing as a result of the outsourcing to Mexico of computer hardware, software, and parts production for the North American market (Austrade, 2009). While more and more Mexican companies are signing joint ventures with North American IT companies relating to outsourcing and assembly operations, increasing numbers of IT companies are also establishing branches in Mexico to provide services to the local market. All these ICT investments in Mexico by its technologically advanced northern neighbours have put pressure on the Mexican government at all levels to invest in and develop ICT- awareness nationwide (Bustos, 2005).

While NAFTA has influenced the Mexican nation more generally, globalisation has created an ICT-oriented, policy-forming Mexican elite. In the 1990s policy-makers realised the importance of a free market and competition. A new policy paradigm came to dominate the Mexican leadership, with the privatisation of the telecommunications sector as the first major step. Initially, the privatisation process was positive. However, a lack of subsequent competition in the field affected the quality and expansion of some services. In an experience mirroring the difficulties encountered in privatising communications utilities worldwide (i.e. Telstra here in Australia), lack of competition in the telecommunications sector has been attributed to the former state-owned and now private monopoly, TELMEX (Mexican Telephones). In recent years, a considerable amount legislation has been passed in order to open up investment in the telecommunications sector (Mariscal, Bonina & Luna, 2007)

In addition to concerns about market regulation, intellectual property protection, anti-piracy rules, and privacy measures, corruption remains an enduring concern among policy-makers and investors. Corruption has always been an issue in Mexico and is something that international investors take into account as a matter of course. The Mexican government has taken different approaches to tackle this issue. Indeed, ICT implementation has itself become a powerful tool in the fight against corruption, as a result of e-government solutions adopted by the federal government. The use of portals to deliver e-services enables Mexican citizens to complete paperwork online, instead of having to be physically present in the corresponding government department. A particularly successful instance has been the use of e-services to pay traffic fines. In the past, this was a considerably source of corruption for the Mexican Police and Traffic authorities. Today, however, with the use of an online system provided by a U.S. vendor, corruption figures have declined significantly in this area (Mexican Federal Police, 2002).

ICT penetration repays any associated implementation costs many times over. Mexico's federal and state governments are convinced of its benefits to the population. Likewise, the majority of the Mexicans who have adopted ICT are keenly aware of the benefits and would be happy to see even more of their fellow countrymen/women join the Digital Revolution. The growth of the Internet in Mexico has been critical to this process.

4.9 The Internet in Mexico

The story of the Internet in Mexico began in 1989 with the link between the Technical Institute of Monterrey (ITESM) and the University of Texas in San Antonio (Conacyt, 2008). Later on, the National Autonomous University of Mexico (UNAM) became the second node, and was linked to the University of Colorado. Other Mexican universities followed the same trend of linking to a North American counterpart, with the connections remaining academic only. However, in 1992 these universities decided to create a public association to regulate Internet policies, called MEXNET. On June 1, 1992, MEXNET established a digital exit of 56kps to the Internet backbone. Not long after, many other institutional users started to register for MEXNET (Conacyt, 2008).

In 1993, the National Council for Science and Technology (CONACYT) connected to the Internet through a satellite link with the NCAR. By the end of 1993, Mexico had a group of well-established nets: MEXNET, UNAMNET, ITESMNET, CONACYTNET, and STRACyT. This latter net attempted to unify them, and in 1994, with the development of the National Technological Net between MEXNET and CONACYT, the link grew to 2Mbps. As a result, the Internet in Mexico turned commercial (Internet Society-Mexico, 2006). The consolidation of the Mexican network was achieved in 1995 in four stages:

- Commercial Internet Service Provider's emerged in numbers and with strength.
- By December the official announcement of the creation of NIC- Mexico was made.
- The USA would (and still does) coordinate and administer the Internet resources assigned to Mexico, such as the register of domain names under .mx.
- The Internet Society Mexico Chapter was born and the Computer Emergency Response Team-Mexico began its operations (NIC- Mexico, 2001 & Internet Society Mexico, 2006).

Internet growth in Mexico since has been exponential, as the following eMarketer report shows.

4.9.i The eMarketer Report

In 2009, eMarketer, an American company that specialises in online market research, released a comprehensive study of the Internet in Mexico. This study used more than 3,000 public sources and generated the most comprehensive database on e-business research ever undertaken (eMarketer FAQ, 2009). EMarketer defines an Internet user as "any person who uses the Internet from any location at least once per month" (eMarketer Mexico online, 2009, p. 2). Its report, titled Mexico Online, explores five different areas of Internet use and activity in the country: Internet access, Internet users, Internet usage, social media, and e-commerce.

4.9.ii Internet Access

EMarketer predicts that by 2012 there will be approximately 43 million Internet uers in Mexico (Table 5), a penetration rate of thirty-seven-point-four percent of the total population.

Table 5. Number of Internet users in Mexico

Year	Internet Users
2012	43 000 000
2011	39 500 000
2010	35 500 000
2009	31 500 000
2008	27 400 000

Note (eMarketer, January 2008)

EMarketer expects to see Mexico remain ranked number 10 worldwide in number of Internet users in the coming years (Table 6)

Table 6. Worldwide Top Ten Countries by Internet use 2009 to 2012

	2009	2010	2011	2012
1. US	200.1	206.2	211.9	216.9
2. China	254.9	294.4	334.4	372.9
3. Japan	92.5	94.0	95.4	96.5
4. Germany	52.5	54.5	56.3	57.9
5. UK	39.4	40.6	41.7	42.8
6. Russia	45.4	50.4	54.9	59.0
7. Brazil	43.7	48.7	52.9	56.7
8. France	38.8	41.2	43.3	45.1
9.India	49.7	59.6	70.3	81.3
10.Mexico	31.5	35.6	39.5	43.0

Note (eMarketer, January 2008)

EMarketer estimates that present broadband use in Mexico constitutes about twenty percent of total Internet use, and it expects it to reach thirty-seven-point-six percent by 2012 (eMarketer Mexico online, 2009).

4.9.iii Internet Users

The main group of Internet users in Mexico are those aged 12 to 17 (Table 7).

Table 7. Internet users in Mexico by age

Age	% of total
6-11	7.7%
12-17	29.2%
18-24	23.9%
25-34	17.1%
35-44	12.1%
45-54	6.6%
55+	3.4%

Note (eMarketer, January 2008)

4.9.iv Internet Usage

Email use is the most prominent Internet activity in Mexico, followed by information searching and online messaging or chatting. Activities linked to broadband such as online gaming, online TV, and video downloading remain low, with e-commerce ranking as the lowest Internet activity in Mexico (eMarketer Mexico online, 2009). Gender distribution of Internet activities in Mexico has remained constant for the past five years (Table 8).

Table 8. Gender distribution of Internet activities in Mexico

Activities	Male	Female
Web	97.5%	98.1%
Mail*	28.2%	28.4%
Audio-video	33.5%	23.5%
Newsgroups	7.0%	5.1%
Chat	13.7%	11.1%
Instant messaging	50.6%	45.2%

*E-mail data concerns POP3 and SMTP protocols, and does not include Web mail services (hotmail.com, caramail.fr...) which are categorised as domains.

Note (Net Value, Oct. 2003)

It can be observed that both Mexican female and male Internet users with access to all Internet-related activities take advantage of these activities in similar ways. One difference occurs in relation to audio-video, a work-related task, which is largely explained by the fact that men outnumber women in image production-related industries.

4.9.v Social Media

Mexico has five million social networking users, almost seventy-three percent of the total number of Internet users (eMarketer Mexico online, 2009).

4.9.vi E-Commerce

Mexico has also been number two in business-to-consumer (B2C) sales in Latin America for the past five years. In the past two years, B2C activities have grown exponentially to $1.6 billion (eMarketer Mexico online, 2009). In spite of these advancements, Mexico still experiences a digital divide that is most pronounced in those areas characterised by lower economic and infrastructure development. This thesis presents a model to complement the Mexican government's efforts to address this gap, in a financially viable manner. The previous two federal governments have set up a long-term strategy to overcome the digital divide called e-Mexico. While for many years federal initiatives in Mexico have lacked continuity due to political factors, e-Mexico has achieved continuity for the reasons outlined below.

4.10 NATIONAL INITIATIVES TO CREATE ICT-AWARENESS

4.11 E-Mexico

On January 5, 2001 the federal government launched the e-Mexico project. Mexican President Vicente Fox explained to the nation that a technical committee for the e-Mexico system had been established and that the handling of the system had been granted to the Communications and Transport Secretariat (SCT), a branch of the federal government. The stated goal of e-Mexico was to interconnect the existing digital infrastructure and to incorporate state-of-the-art technology in both computers and networks, in order to match the expectations and needs of Mexican society in relation to government services, education, health, and transparency and efficiency in commerce.

With e-Mexico, the federal government would seek to integrate all the existing networks, be they public or private sector, into a single *mega net*. It would select the best content material for the system and then commence to provide government services through this new infrastructure. As President Vicente Fox put it, the goal of e-Mexico was to turn Mexico into a digital economy and, in so doing, a more democratic country.

The e-Mexico website (2005), explains that the program is divided into four groups (Figure 17):

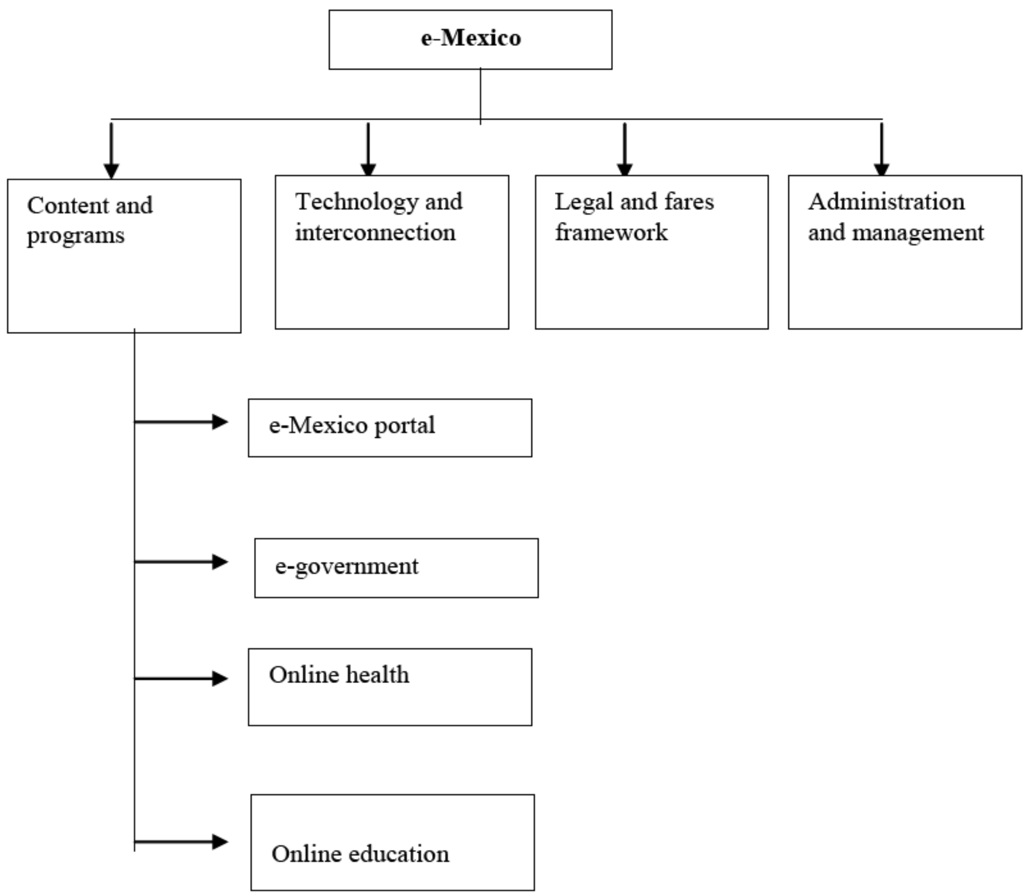


Figure 17. E-Mexico Program Structure

4.11.i The Philosophy of e-Mexico

In an interview in 2000 on behalf of Canal Software Mexico, Julio Cesar Margain Campean, former e-Mexico CEO, described the philosophy behind e-Mexico. During the interview he talked about the three stages of the project. Initially, he described "stage zero", which consisted of a survey of the human and technological resources available throughout government that needed to be connected to the government net, or e-government. The survey included a database, technical information about the state's IT and telecommunications equipment and infrastructure, a description of the systems involved in the areas of public attendance and form-filling, and the IT systems of each government body. The survey data provided the framework for an egovernment network to foster the sharing of information among federal, local, and municipal governments throughout the Mexican Republic. This goal has been achieved through a link to a central node, whose function is to manage the Net.

Stage one of the project involved connecting the 2,470 municipal governments throughout Mexico. The cost of this stage was US$650,000, and was sponsored in part by multinational companies such as Compaq, EDS, HP, Microsoft, Oracle, PriceWaterhouse Coopers, and Sun Microsystems. Stage two involved the transformation of national telegraph offices around the country, into Community Telecentres. Margain explained that the SCT was focused on two types of readily-accessible institutions, namely the roughly 2,000 post offices and 2,000 telegraph offices in around 1,000 different locations throughout Mexico. Each telegraph office had its own IT equipment previously set up. These community telecentres would provide services in education, entertainment, health, government, culture, and security, in addition to direct access to the national database and the Internet. All services would be available online, in real-time, and at an accessible cost. From January to March 2001, 60 telecentres were established in various urban and rural areas. Between April 2001 and December 2003, 2,000 more telecentres were operating. Margain concluded the interview by saying that the ultimate goal was to cover every Mexican school. By 2005, that goal had been achieved. As of 2008, e-Mexico has operated continuously to provide online services and information to the Mexican population. The operation and structure of e-Mexico remains the same and its implementation is yielding quantifiable results according to the e-Mexico website (2008).

E-education, the subsystem within e-Mexico dedicated to education, aims to take advantage of new telecommunication and information technologies in order to improve online education in Mexico. "E-education looks forward to the expansion of current educational services and to a rise in the levels of education of the Mexican population regardless of ethnic or linguistic background", as stated by the SEP employee Gustavo Flores during a public forum about e-education (e-Mexico, 2005). To date, content production in e-education has been limited. The portal functions primarily as an informative point of reference and consultation on educational and cultural matters. Educational guidelines come from the Public Education Secretariat (SEP) and the Distance Education programs it operates (e-Mexico website, 2008).

Since e-Mexico's inception, some corporations have made specific pledges of support. For example, on August 10, 2001, Canal Software Mexico reported through its online news service that Compaq CEO Michael Capellas had announced that Compaq would have reached US$2 million in equipment donations to public schools across Mexico by 2002. He added that in the previous two years they had made donations totalling US$1.2 million to 84 public schools and more than 50,000 students (Canal Software online news service, 2001). Similarly, Canal Software's news service reported on June 19, 2001, that Intel Corporation and the Latin American Institute for Education and Communication (ILCE) had signed an agreement to provide the technology required to train 7,000 teachers. ILCE was chosen as the training agency for Intel's program *Educating for the Future* (*Educar para el Futuro*) in Mexico. This program involved four Mexican states: Chiapas, Guanajuato, Nuevo Leon, and Guadalajara, with a budget per teacher of approximately US$1,200. The project consisted of training professors to handle technology effectively inside the classroom, teaching science and mathematics in K- 12, and encouraging students to pursue a technical career to broaden technology access (Canal Software, 2001). A Canal Software report went on to claim that Intel had also invested US$100 million to train almost 400,000 students worldwide, as part of their global project Educating for the Future. According to Julio Margain Campean, then head of e-Mexico, the Mexican government had done its part by committing the resources of the Public Education Secretariat (SEP), the National Pedagogy University, the ILCE, the National Indigenous Institute, the Mexican Institute for Social Security (IMSS), to the pursuit of e-Mexico's educational goals (Canal Software interview, 2001).

In short, e-Mexico is a national initiative to tackle ICT- awareness and infrastructure, and while it has encountered some challenges relating to proper management and funding, it is generally considered a success. However, e-Mexico is not the only initiative currently taking place. SEP has been involved in other ICT projects for years.

4.11.ii SEP

Distance education has long been an important component of attempts to increase the coverage, and improve the quality and efficiency, of education in Mexico. SEP has implemented numerous distance education programs in the past 30 years, since the emergence of Telesecondary in 1968. Using digital and satellite communication technologies, the federal government, through SEP, has been able to develop basic programs to achieve its distance education goals. These include the Television Education Satellite Network (Edusat Network), the Educational Informatics School Network (School Network), and Telesecondary (Distance Education in Mexico, SEP, 2005).

4.11.iii Edusat

Edusat encompasses receiving equipment, a television studio and broadcasting network set up by edusat in schools and other educational centres. This educational television network utilises six channels to transmit educational content, training, supplementary material for the teacher, adult education, continuing education, and additional educational program productions such as *Discovery Kids*.

Currently Edusat enjoys nationwide coverage, including the southern United States and Central America. It commenced operations in August 1995, with the main goal of providing much-needed ICT infrastructure. By 1999, almost 33, 500 units had been established in different educational centres throughout Mexico. Equipment to download the Edusat signal can be found in Bolivia, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Nicaragua, Panama, the Dominican Republic, the southern United States, and Canada. Between 1995 and 1999, Edusat broadcast almost 36,000 hours of educational programming, seventy percent of which was produced by national public institutions. The Edusat Network signal is delivered with the support of the Latin American Institute for Educational Communications (ILCE) and the Educational Television Unit (UTE). ILCE is an international organisation headquartered in Mexico City which was created to improve education through the use of electronic media. Some of its activities are described later. UTE is a body within SEP for the production of educational television programs. In 1999 they produced almost 4,000 hours of educational program material and broadcast for approximately 25,000 hours.

Edusat currently broadcast the following productions:

- *Education for Society*: A series of productions using audiovisual materials that combine entertainment with learning. They follow particular educational content: 1) Issues on development and sustainability; 2) Conflict-resolution and human rights education, social order, and democratic values; 3) Awareness on environment and natural resources issues and preservation; 4) Disability subjects regarding integration into mainstream society; 5) Education on gender relationships and coexistance; 6) Education on native culture and society and other relevant issues of social and cultural nature.

- *Modernisation and Improvement of the Teaching Profession*: These productions follow the guidelines of the National Program for the Permanent Modernisation of Basic Education Services.

- *National Educational and Cultural Video Library and School Video Libraries*: These include all the productions that SEP has produced. The subjects covered include Spanish, mathematics, social and natural science and technology, Mexican history, chemistry, and biology, with the teacher guiding students through the material.

- *The SEP English Program*: SEP and the British Broadcasting Corporation (BBC) generated a total of 600,000 learning units to improve the teaching of English. Each unit includes a book and two audiocassettes. The SEP English course, which lasted for two years, was organised in four categories: initial, basic, general I, and general II. Multiple members of the educational community like telesecundary and traditional primary, secondary and high school students and teachers, and public servants joined the program. Graduates from the progam had their qualifications recognised by the Mexican and British governments (Distance Education in Mexico, 2005).

4.11.iv School Network

School Network started in 1997. Its goal is to foster the use of the Internet as a new channel of communication by connecting Mexico's primary and secondary institutions, as well as teacher training schools and teachers' centres. School Network follows a constructionistic philosophy and has expanded its services to Ibero America (the communities of Latin America, Spain, and Portugal) benefiting almost three million students and 15,364 schools (School Network Impact, 2008).

4.11.v Telesecondary

The Telesecondary program started in 1968, and its main objective has been to deliver educational content to rural Mexico. It targets communities with a population of 2,500 or less, where building a public secondary school is simply not practical. It is aimed at those students who have completed elementary school. Classrooms are especially set up for Telesecondary. Each of them is provided with digital hardware tools to link to the Edusat Network. This equipment includes a screen television, a satellite receiver and a decoder device within each classroom. The classrooms have an aproximately 20 students assigned to a teacher who has received prior and ongoing training in this delivery method. Telesecondary works together with the the National Council for Educational Development (CONAFE), the National Institute for Adult Education (INEA) and the Indigenous Education Direction (DGEI). Telesecondary began with two-point-five percent of the total enrolments for secondary education. That figure increased to eleven percent in the 1990s, to twenty percent in 2000, and to twenty-point-seven-seven percent by the end of 2005 (Martinez, 2008).

4.11.vi ILCE

ILCE’s (Instituto Latinoamericano de Comunicacion Educativa) main function is to deliver education through the use of communication technologies all over Latin America.

The Institute was established in Mexico City in 1954, as the result of a proposal from the Mexican government during UNESCO's General Conference in Montevideo, Uruguay. First known as the Latin American Institute of Educational Cinematography (Instituto Latinoamericano de la Cinematografia Educativa) its goal was to promote regional cooperation among Latin-American countries and the Caribbean, through audiovisual media applied to education. In 1969 ILCE took on its current name, Instituto Latinoamericano de la Comunicacion Educativa, in response to the emergence of new technologies like computers. During the 1970s, ILCE's productions were mainly in the form of diapositives and slides, containing both educational and cultural content. While UNESCO initially supported ILCE financially, in 1976 the funds were cut as a result of the decision taken during the 19th UNESCO General Conference. From that time on, funds have been provided by the governments of member countries.

In May 1978, during the second meeting of the ILCE's Council, the 13 member countries signed a cooperation agreement. This agreement, which still governs the institute, adapted some of the operations of ILCE to the emerging media technologies of the time, such as video. In the first half of the 1980s, ILCE transferred its delivery method to diaporamas (diapositives transferred to video with narratives). The second half of the 1980s saw a wholesale shift to video production, as well as the first Master's degree in Educational Technology being offered.

Since the late 1990s, ILCE and SEP have been working hand-in-hand to design and produce distance education programs. Currently six of the 10 channels are on the Edusat network, four are operated by ILCE, and two are rebroadcast on different networks (*Discovery Kids* and *Canal Class*). Besides having the broadcasting rights to many educational programs, including those broadcast as far away as Australia by the Australian Broadcasting Commission (ABC), ILCE has its own studio production facilities where it produces educational and cultural programs, teleconferences, and training courses (ILCE's history, 2004).

Likewise, ILCE develops and operates the School Network. During 1999, the third stage of expansion of the School Network took place. The results included: the equipping of 423 secondary schools with 2,305 units of equipment from ILCE and 2,115 from local authorities; the strengthening of 138 teachers' centres with 522 units of equipment, two per centre, of which 266 were provided by the local authorities and the rest by ILCE; and the support of 1,392 elementary schools with pre-existing equipment (one server per school provided by ILCE). By 2000, 2,587 secondary and technical schools, 1,187 elementary schools, and 25 teachers' centres were equipped and connected to the school network. By 2001, almost 5,580 schools had been connected and equipped. This represents approximately fifty-six percent of the total number of secondary and technical schools (9,912) in Mexico.

One of ILCE's main activities has been the promotion of postgraduate courses relating to educational communication technologies. ILCE carries out this function through its Research Centre for Communication and Technology, (Centro de Estudios en Comunicacion y Tecnologias Educativas, or CECTE). CECTE offers a Latin American research and development postgraduate program consisting of two levels, a graduate diploma and a masters in communication and educational technologies, with plans to introduce a PhD program. CECTE also provides an ongoing teacher-training program, delivered through both open and distance conferences, seminars, workshops, and courses (ILCE's history, 2004).

In 1999, CECTE reached 2120 students, raising ILCE's number of Edusat telesessions from 33 in 1998 to 77. An additional 33 audio conferences were held in 1999, compared to the year before, as part of the postgraduate program. Aside from Mexico City, the graduate diploma and masters degree was also offered in 12 other locations. In order to keep the masters program updated, and to properly design the content of the PhD program, four modules and 15 workshops were provided. A complementary service provided by CECTE involves supporting courses and seminars which provide advice on thesis procedure, structure, and writing. In 1999, 103 students attended these seminars with 60 theses submitted.

ILCE also undertakes research along two lines: applied research and assessing education products and process. The former involves seeking out better educational models and adapting communications technologies to the Latin American sphere in general, and the local Mexican sphere in particular. The latter has to do with evaluating the performance of programs and projects, both within the institute and outside of it. Research within ILCE involves every possible discipline in the education field. Papers and research results are available in different publications, seminars, and educational forums. One of these compilations has been published by the Research Lab in Educational Media, (Laboratorio de Investigacion de Medios en la Educacion). It consists of different investigations into the use and application of new technologies within the educational process. ILCE has currently set out basic requirements for the research lab, and the group involved is working within a learning protocol environment.

ILCE also hosts the Library Centre for Latin America (Centro de Documentacion para America Latina, or CEDAL). CEDAL is a documentation centre specialising in educational technology, educational communication, and distance education. It holds nearly 40,000 volumes. Since the 1970s CEDAL has been the trustee of the Japan Prize, (Premio Japon) and videotec, a compilation of international educational programs for the Latin American region. CEDAL has developed different storage information systems and provides access to all its databases. The bibliographic, document, and audiovisual codification procedures are of particular relevance. In 1999 the database was updated with more than 1,200 new issues: 237documents, 492 books, and 496 specialised publications on communication and education technologies.

CEDAL has 124 agreements covering inter-library loans with other Mexican institutions, and it added 97 to the previous 81 with international institutions in Brazil, Colombia, Costa Rica, Cuba, Chile, Ecuador, Spain, Guatemala, England, Japan, Panama, Peru, and Venezuela. By 1999, CEDAL had 10,600 resources in its electronic records, including 600 additional titles for that year, and 3,305 records in the database of analytic abstracts, published in The Technology and Educational Communication Magazine, *Revista Tecnologica y Comunicacion Educativa del ILCE*. The monthly bulletin, *Sumarios*, uploaded inside the CEDAL web page, informs readers about the new acquisitions. In the same year (1999), CEDAL served 13,244 users, at an average of 1,103 visits per month. CEDAL also trains its personnel. CEDAL's employees undertake an audiovisual documentation course, organised by the Training Centre for Educational Television (Centro de Entrenamiento de Television Educativa, or CETE) and the General Directorate of Education Television for the Ministry of Public Education (Direccion

General de Television Educativa de la Secretaria de Educacion Publica, or GTE). In addition, they attend the Mexican Association of Librarians (Jornadas Mexicanas de Biblioteconomia) (ILCE's History, 2004).

SEP and ILCE's efforts have been recognised both in Mexico and internationally. Nonetheless, state governments have realised that many federal government solutions simply fail to reach their local populations. As a result, most Mexican states have created their own ICT- awareness initiatives. The most outstanding thus far has taken place in the state of Puebla.

4.12 Puebla

Puebla is a state in the southeast centre of Mexico, an hour's drive from Mexico City. It is the fifth most populated state in Mexico, with a total population of 5.2 million, 1.8 million of whom are of high school age (15 to 22). Puebla also ranks second nationally in terms of the number of higher education institutions. It is also the only state in which every type of educational model existing in the country can be found (Miranda, personal communication, 3 April, 2004). In 1998, Mr Morales Melquiades became governor of the state of Puebla. That same year he launched the Digital Puebla initiative, which he heralded as a social program to foster state development through the use of digital technology.

4.13 DIGITAL PUEBLA CONCEPTUALISATION

Digital Puebla is the state of Puebla's e-government initiative. Puebla´s governor, Melquiades, understood the necessity and benefits of integrating Puebla into the digital world. Puebla´s e-government project is outlined in the state development plan from 1998 to 2004 (Melquiades's period as governor). This document outlines the main tenets of the Digital Puebla philosophy as being the provision of highest quality government services and technological development. Digital Puebla was developed through the State Finance and Social Development Ministry, SFDS, formerly headed by Dr. Rafael Moreno Valle (Digital Puebla Portal, 2002). Digital Puebla is a portal and uses some of the newest technologies in web application, such as BEA (Moreno Valle, 2004). The project has three goals:

- To close the digital divide in the state
- To digitalise and thereby improve government services (e-government)
- To modernise the internal operations of the state ministries (Moreno Valle, 2001).

In order to reduce the gap in Internet usage in the state, 800 government employees were trained in email communication and web surfing as a first step. At the same time, a finance program was introduced to help 3,000 employees obtain computers via loans. Digital Puebla has set up 15 regional centres to provide internet training. These centres facilitate the establishment of internet kiosks, internet cafes, and computerised web-based classrooms. One hundred and thirty internet kiosks were set up with the aim of covering every city in the state of Puebla. Each of these kiosks provides free web browsing to almost 400 users per week. An additional strategy to close the digital divide was to connect the state public school system to the Internet. This resulted in 460 primary, secondary, and high schools providing free internet access to almost 400,000 students. Likewise, 10 computer labs were established in a selection of primary, secondary, and high schools. These labs provided Internet usage and training to almost 200 students per laboratory.

In accordance with the program's second goal, Digital Puebla has sought to find better ways to serve the Puebla population. A preliminary approach to achieve this has been the establishment of a regulatory framework for all government IT activities and services in the state of Puebla. The document outlines how Digital Puebla aims to digitalise government services and make them accessible through a single Digital Puebla portal, in the establishment of an e-government system. Currently all state government ministries participate in the Digital Puebla program. Having these various departments online together through a single portal not only makes their services more accessible and their operations more transparent to the public, it has also lessened the problem of the unnecessary duplication of government services. With the necessary budget, Digital Puebla has re-engineered government services such as fine payments, licence payments, and even tax payments, to an online setting. Indeed, it has gone so far as to create virtual libraries. In facilitating the relationship between its citizenry and its public institutions, Digital Puebla's functionality can be seen to match that of any of its counterparts in developed countries (Moreno Valle, 2004).

4.14 Digital Puebla as an Innovation and the Process of Diffusion

Before the Digital Puebla portal was rolled out, the first step was to promote the project among the population. To achieve this, the Digital Puebla team looked to the diffusion of innovations model provided by Rogers.

4.14.i Rate of Adoption

According to Rogers (1995), the rate of adoption of a particular innovation is determined by five characteristics of that innovation as perceived by the individual or the group: relative advantage, compatibility, complexity, provability, and observability.

4.14.ii Relative Advantage

Relative advantage refers to the perception of an innovation as being better than the concept it renews or improves. The different ways of measuring relative advantage include: economic benefits, social prestige, convenience, and satisfaction. A perception of relatively greater advantage leads to a faster adoption rate. According to Rogers, what matters is the individual's view, not a technological deterministic view. In the state of Puebla, as in many other states in the Mexican Republic, and other countries in Latin America, the governor saw the necessity of an e-government initiative to improve the government's functioning and its services, and to thereby raise the standard of living of the *Poblanos* (people born and living in Puebla).

4.14.iii Compatability

Compatibility refers to the extent that an innovation addresses the needs, values, and experiences of the individual or group. Innovations perceived as being congruent with a particular social structure will be adopted faster than innovations not perceived as such. Incompatibility in the process of adoption usually requires prior adoption of a new social system slowing down the whole process (Rogers, 1995). The state of Puebla established two joint actions to achieve compatability:

- The first saw the government establish Technology Learning Centres (TLCs) in different sectors of the community and with diverse initiatives.
- The second was to investigate the question of how best to configure and adapt these TLCs so as to establish communities of knowledge and to thereby improve the productivity and standard of living of the Pueblan community?

The research and experience gained in answering these and other questions related to the use and advantages of TLCs, lead the Digital Puebla team to integrate a diverse range of governmental institutions: private, educational, productive, and social. This in turn led to the establishment of Puebla's Learning Independence Network. The network subsequently collated the experiences, research, and results of countries with similar contexts to Mexico across Latin America, and the world. In particular, the Digital Puebla team were able to establish a close collaboration with the Media Lab of the Massachusetts Institute of Technology (MIT), facilitated in part through the support of the Mexican telecommunications giant Telefonos de Mexico (Telmex) and its associated Institute of

Technology (Intelmex). Through its association with Telmex, state governor Melquiades Morales and Telmex Director, Javier Elguea Solis, subsequently shook hands over an alliance between Digital Puebla and Intelmex's Cultural Digital Centre (CCD), thereby signalling that Puebla was ready for the digital revolution. As a result of this agreement, the Digital Puebla team were privy to up-to-the-minute technological research and applications. This inside knowledge proved vital in the development of Technology Learning Centres, equipped to tackle the digital divide that had developed over time in the state of Puebla (Miranda, personal communication, April 3, 2004).

Complexity, provability, and observability round out Roger's characterisation of the factors that can be seen to determine the rate of adoption of technological innovations. According to Rogers, complexity denotes the level of understanding and provability of an innovation. An innovation perceived as complex will take longer to be adopted. Provability indicates the extent to which the innovation can be trialled. If the innovation can be tested by the public at an early stage, they will be less uncertain about the new idea down the track. Observability is the visibility of the innovation's results. If the results are visible or tangible, then the individual or group will again have less uncertainty about the innovation, thereby increasing its likelihood of adoption.

As we have seen, the greater the relative advantage, compatibility, complexity, provability, and observability of an innovation, the geater its chances of being adopted quickly will be. Today, Digital Puebla's portal is fully operational and has evolved into a place of reference for every activity related to e-government and online information. It complies with standard portal requirements relating to connectivity, content development and production, community, e-commerce, e-government, and e-learning. The services delivered through the portal encompass tax payments, car registration, paperwork and form-filling for public services, environmental tracking, and a specific electronic complaints form. As mentioned earlier, every government ministry has a link inside the portal (Puebla digital portal, 2008)

4.15 Communication Channel

The communication channel is the medium that an individual uses to share communication within a group. A group becomes aware of an innovation through a channel of communication, for example, television or the Internet. In regions characterised by low ICT-awareness and relatively limited penetration of other media, peer-to-peer communication is the most common channel. Puebla's single-minded commitment to ICT resulted in the digital government program "www.puebla.gob.mx". This program operates through a variety of different channels, such as Information and Communication System (SICOM) internet centres, the Public Education State Secretariat, TyLTES, e-Mexico, Telesecundarias, Redescolar, and many others. The e-knowledge component of Digital Puebla emerged as a result of the collaboration between the Intelmex Centre of Digital Culture, the MIT Media Lab, and the Pueblan state government.

In 1999, Intelmex invited representatives from the Pueblan educational community, the Pueblan communications industry, and Digital Puebla to the first workshop of the consortium of Digital Nations involving MIT's Media Lab, entitled *The Rapid Development of Technological Prototypes to Respond to Community and Educative Challenges*. This was done in order to share the results of the joint investigations undertaken by Intelmex's Cultural Digital Centre (CCD) and MIT's Media Lab. The workshop went for five days at the National Institute of Astrophysics, Optics and Electronics (Instituto Nacional de Astrofisica, Optica y Electronica, INAOE) in Sta. Maria Tonantzintla, Puebla. It was chaired by Doctor Bakhtiar Milkhak with the help of Eleonora Badilla Saxe, Tim Gorton, Chris Lyon, and with the participation of guests from Brasil, Costa Rica, and Panama. In addition to developing prototypes with MIT, a constructionist project developed by MIT's Media Lab called the *Tower System* (Pinkett, 2000), came to dominate the workshop. As a result, the Digital Puebla team considered constructionism as an alternative means to achieve its goals.

They investigated formulas for learning and knowledge construction that would suit every poblano regardless of age, gender, or ethnicity. The first approach was to take up Seymour Papert's (1981) proposal for constructionism. Papert's proposal is seen as an alternative to achieve significant and radical changes in the ways of thinking of children, adolescents, and adults (Miranda, personal communication, 3 April, 2004). As a result, MIT's Tower System, an evolution of Papert's ground-breaking work, came to be the preferred option. The Digital Puebla team felt that this technology could best facilitate the physical expression of what the user conceives in his or her mind, according to Papert's notion of a *powerful idea* (1982).

The Digital Puebla team understood that the learner must be joyfully engaged during the process of actively constructing a public entity like the Tower System (Pinkett, 2000). The Tower System sees itself as:

> a toolkit designed to realize this potential. This toolkit consists of a large collection of hardware modules and a customizable, modular virtual machine

for rapid prototyping hardware, firmware and software components of sensing and monitoring, actuation and display, wireless communication and networking applications. One particularly interesting application of the Tower System is designing and building all the programming, diagnostic, and manufacturing tools needed to build full new Towers (The Tower Vision, 2002, para. 3).

4.15.i E- Knowledge

The e-knowledge program strives to integrate and identify the ICT and learning methodologies best suited to the State of Puebla's context. The main project involves providing personal computers and Internet access to every region in the State of Puebla through SICOM.

4.16. SICOM

SICOM's main goal is to reduce the digital divide in the state by using both traditional and new communication technologies in conjunction with its 12 regional centres and particular institutions such as the Headquarters Media Library (Mediateca del Centro Estatal). SICOM works jointly with the Satellite Education Network (Satelital Educacion Network, an Edusat-federal project), which incorporates 1,617 centres wherein state and local institutions share and co-produce educational content. SICOM uses radio, television, and ICT to achieve its goals.

4.16.i SICOM Radio

SICOM Radio's frequency is 105.9 fm, and its network covers eighty-five percent of the State of Puebla. The main goal of SICOM Radio is to have a socially-oriented station open to all of Puebla's citizens. Its regular transmissions include award-winning programs such as Encuentros en Comunidad (Community Encounters) and Cada Dia Algo Diferente (Something Different Everyday), plus regular news bulletins broadcast from the New State System (SEN). A very successful SICOM Radio initiative has been The Kids Club. This program's contribution to child education has been recognised with a host of national awards. The Kids Club is a space on air where Puebla's children can express their views directly, and are eligible for various benefits through their membership in the club. SICOM Radio also promotes university students' projects. During May 2003, ten out of the 100 projects submitted by tertiary students were awarded by being integrated into SICOM Radio's regular programming.

4.16.ii SICOM Television

SICOM Television's flagship channel, Channel 26, was launched in November 2003 and was the first of its kind in Puebla. Channel 26 broadcasts an open signal 24 hours a day from the State's capital to 24 surrounding municipalities to a total of two million viewers. Its charter is to create pride in being a poblano and to foster harmony among the state's communities. To achieve this, Channel 26 operates according to four principles: to entertain, to promote positive messages and pride in the community, to promote social consciousness, and to educate. It started with four internal productions mainly relating to social, entertainment, and cultural aspects of Puebla. At the same time, just a month before the launching of the channel, an agreement between SICOM and the division of Educational Television from the National Education Secretariat (DGTVE), was signed. This deal enabled Channel 26 to re-broadcast part of EDUSAT's (see the Edusat section) signal on a daily basis. The agreement also included the donation of approximately 7,000 video programs to the Headquarters Media Library (Mediateca del Centro Estatal) which are available to be borrowed by anyone. This figure adds to the almost 7,000 videos already in the media library. In addition, the National Education Secretariat (DGTVE) has been training SICOM Television personnel through its educational television training centre.

4.16.iii SICOM ICT

SICOM's ICT department is very important to an understanding of Digital Puebla's strategy. Indeed, it is fundamental to SICOM's goals. One of the main projects involving SICOM ICT has been the updating and upgrading of the School of Bachilleres (Colegio de Bachilleres, COBAEP) database and Internet connectivity. The School of Bachilleres is a technical high school with 32 campuses throughout the state, catering to almost 20,000 students. SICOM ICT has committed to connecting every campus to the Internet and to developing an educational portal for students and the general public alike.

4.16.iv CID

SICOM conducts research into information and communication technologies and other media through the Information and Development Centre (CID). CID focuses on radio, television, and ICT in the search for better learning environments. Its achievements have been numerous, having won several grants to develop research in several of the state's municipalities. In addition, CID has represented SICOM at a variety of international forums such as the second Latin-American Conference for Community Telecentres that took place in the City of Quito, Ecuador. This conference involved the participation of Latin American ICT-related organisations in the exchange ideas and proposals to develop ICT in disadvantaged regions.

4.16.v Regional Centres

SICOM has 12 regional centres across the state of Puebla, in the municipalities of Ciudad Serdan, Huachinango, Huehuetla, Libres, Tehuacan, Tepeaca, Teziutlan, Zacapoaxtla, and Zacatlan. These centres, initially featuring ten computers with dial-up Internet access, are public spaces where anyone can access the entirety of SICOM's educational and cultural services. Each centre has its own computer area, consulting section, and multi-use hall (Manjarrez, personal communication, 24 April, 2006)

The research for this thesis was conducted in SICOM's Tepeaca centre. Tepeaca was selected because it is a region characterised by low ICT-awareness. SICOM authorities granted me permission to conduct experimental research using the centre's computers. The entire experiment is detailed in the Chapter Five.

4.17 DIFFUSION AND TIME

According to Rogers (1995), time is involved in the diffusion process in three different ways. First, the decision-making process, whereby the individual analyses the innovation to decide whether or not to adopt it, requires time. Second, the *innovativeness* of an individual, the degree of openness to adoption in an individual in comparison to his/her group, will determine the speed at which adoption takes place. The greater the degree of innovativeness on the part of the individual, the faster the adoption of an innovation will occur. The third way that time is involved in the diffusion process is through the rate of adoption itself. The rate of adoption is obtained by dividing the total number of members who adopt the innovation by the period of time it took them to do so. Rogers argues that individuals can be seen to fall into five categories of innovativeness: innovators, early adopters, early majority, late majority, and laggards.

Rogers (1995) indicates that the innovators represent the first two point five percent of the group. They adopt technology based on the technology itself, and tend to set themselves apart from their local group by establishing networks with other innovators. Importantly, a successful rate of adoption overall depends on its success with this group in particular. Uncertainty at this stage is higher and the risks greater, than at any other stage. The innovators are the gateway for an innovation to spread to the wider population, and consequently, if they choose not to embrace an innovation, its prospects at the wider level are placed in jeopardy.

Early adopters constitute the next thirteen point five percent of the population. They remain more connected to the local group than the innovators. Early adopters are the point of reference for the remaining personality types due to their local-orientation, in contrast to the cosmopolitism of the innovators. As a result, this category exerts decisive opinion leadership. Change agents look to early adopters as a reference point for their choices in relation to the diffusion process. Early adopters are aware of their position in the social network and feel responsible for making informed, progressive decisions that will benefit the group.

The early majority encompasses the next thrity-four percent of the group. They are not opinion leaders and merely act as a link in the diffusion process between early and late adopters. The late majority includes the other big group of adopters, with another thirty-four percent of the total number of individuals. Their adoption process is shaped more by pressure from higher-ranking groups, than by personal conviction. Being conformist in nature, this group decides about an innovation in reference to its suitability to the social system's norms. A lack of information resources on the part of this group means that most of the uncertainty about an innovation has to be removed. The remaining sixteen percent of the population are called laggards. They tend to be isolated from the social network. Their point of reference is what has been done in the past. They have to be certain that the degree of uncertainty is almost nonexistent before they adopt a technology.

Digital Puebla's strategy was to select individual early adopters who were representative of the general population. To better demonstrate this I use the case of Juan, which was described to me in detail by the Digital Puebla team. Juan was an 11-year-old boy who after the first workshop participated in an experiment with children from the Luis Enrique Herro secondary school. Just seven days after having finished the workshop with Baktiar, Juan resolved the problem of a crane with three grades of freedom. This problem would normally be considered inappropriate and too complex for a boy of Juan's age, especially given that he was regarded as a problem child in his group, having failed the subjects of physics and mathematics (skills that he ostensibly required for the challenge). None of the children who participated in the Luis Enrique Herro school experiment, including Juan, had ever used a computer. After the experiment, all demonstrated higher skills in trigonometry, program logic, and discovery techniques. In Juan's case, additional positive formative aspects that are not commonly seen in problem children became apparent. He showed a remarkable increase in interaction with his peers. When the entire group programmed the Tower System the teacher was amazed at the level of cooperation evident among the children. As a result of this experiment, Juan's self-esteem was reinforced and his recognition as a part of the group became clear.

4.18 THE SOCIAL SYSTEM

The social system refers to the network of individuals that interact to achieve a similar goal. The network of individuals could be people, groups, organisations, or institutions. The social system is the bounded entity in which the diffusion process takes place. The change agent operates within the social system and tries to influence the decision-processes of other individuals. Change agents attempt to reach critical mass, whereby the rate of adoption then becomes self-sustaining. The Digital Puebla team realised both that the Tower System could exceed any expectations relating to behavioural therapy on the part of the school psychologist, and that it was a change agent.

As a result, the Pueblan state government acquired 20 towers for research purposes. Digital Puebla designed a strategy in consultation with the researchers from the CCD and MIT's Media Lab. The discussions resulted in a series of activities:

- Workshops were conducted for three weeks at the Technological University of Tecamachalco and in SICOM centres.
- The Autonomous University of the State of Puebla (BUAP) used the towers for support in the construction of prototypes, during the development of student dissertations in the field of Electronic Engineering.
- INAOE and the UDLA-P established the protocol for a research project to be submitted for consideration by institutions that could finance it (Miranda, personal communication, 3 April, 2004).

Between February 24 and 28 of 2002, the Technological University of Tecamachalco held a workshop involving teachers and students of computer science, graphic design, and languages. Initially, the teachers' participation in the workshop proved to be problematical. The students, by contrast, showed a real willingness to be part of a team and to listen to the opinions of others. Students continue to assist in these workshops, where multiple towers from the Tower System are being used as an alternative learning tool. This activity has drawn the attention (and ire) of a considerable number of teachers and career advisors, who want to know why their pupils prefer participating in the construction of these educational prototypes to participating in more traditional, formal classes.

Another computer science conference took place between April 2 and April 4 of that same year, 2002. This three-day workshop was for students pursuing bachelor degrees in computer science and telematics. The response to the invitation to attend was very positive, with equal interest from both genders, as well as from students from other disciplines. During the workshop, when a group of industrial design or mechanical engineering students were confronted with issues beyond the scope of their subject areas, they sought help from students of different disciplines, such as law or history. The main exchange of information related to computer hardware. Three secondary students asked that they be allowed to conduct their work experience program in computer science applications. The activity assigned to them was to work freely with the Tower System. While initially they showed little interest, as time went by their change in attitude was radical. Their task was to build a crane, which necessitated that they learn how to look for information on the Internet. They re-learned the topics of trigonometry and geometry, and sketched out their designs with rudimentary design software such as Paint. They then learned and used AutoCAD, as well as searching for free software that allowed them to be more dynamic in their task.

Each of the projects mentioned above changed the mindset and learning processes of the computer science students involved. As a result, this approach to learning through participation has become part of the curriculum in a number of universities throughout the state of Puebla. The Digital Puebla team currently supports four groups within universities, which determinate their own activities. The first group focuses on software production, the second group is dedicated to hardware development, the third relates to computer networking, and the fourth is dedicated to ecology, and the recycling of aluminium cans in particular (Miranda, personal communication, 3 April, 2007).

The philosophy of these groups is anchored in constructivist and constructionist approaches to learning. Students and staff set their own pace and workload. In this process, Digital Puebla researchers have observed the creation of subgroups. Some of the subgroups prefer to conduct research, others deal with diffusion and the publication of results, some handle financial aspects, and others deal with management issues. Regardless of group, or subgroup, at the end of the planning and execution processes, each member acquires a greater or lesser degree of knowledge. The knowledge attained in the areas of hardware and software implementation and development in particular, is of great value. The process of integrating learning and technology equips group members with the tools to tackle future school projects and future work opportunities. At the same time, becoming part of a team raises the self-esteem of these students, it improves their capabilities in oral and written expression, instills the importance of learning English, develops their self-learning mental settings, and improves their research skills.

While the process of knowledge acquisition developed through these Digital Puebla, Intelmex, and MIT Media Lab-sponsored workshops has been very positive, a problem remains; namely that this knowledge remains confined to the University level and to metropolitan areas of the state. Digital Puebla's vision is to tackle the digital divide, not to promote it. Consequently, its main focus continues to be on delivering the Internet and every possible online service to the state's population as a whole.

4.19 THE MODEL'S EVOLUTION AND LOW ICT-AWARE REGIONS

This thesis documents an experiment in a low ICT-aware region of Mexico aimed at testing the hypothesis that e-Ludic learning can provide an effective alternative educational tool to create ICT-awareness. Digital Puebla provided the setting, population, and infrastructure necessary for the experiment. Their penetration strategy, based on the diffusion of innovations model, provided the author with the idea of adoption as part of the e-Ludic model evolution. If e-Ludic learning is adopted early by certain members of the group, as in the case of Juan and the towers system referred to above, then it can be predicted to diffuse effectively throughout the group. This empirical assumption was not tested in the thesis experiment but was observed by the research assistant. If adoption of the experiment on the part of members of the experimental group had not occurred, the experiment could not have continued. At the same time, Hilbert's concept of technological leapfrog cannot be applied in the absence of ICT-awareness. Accordingly, the Digital Puebla experiment was able to add the technological leapfrog concept to its e-Ludic model as a consequence of adoption and ICT-awareness. The experiment tested e-Ludic learning as an effective alternative tool and as an instrument of ICT-awareness in the manner described next.

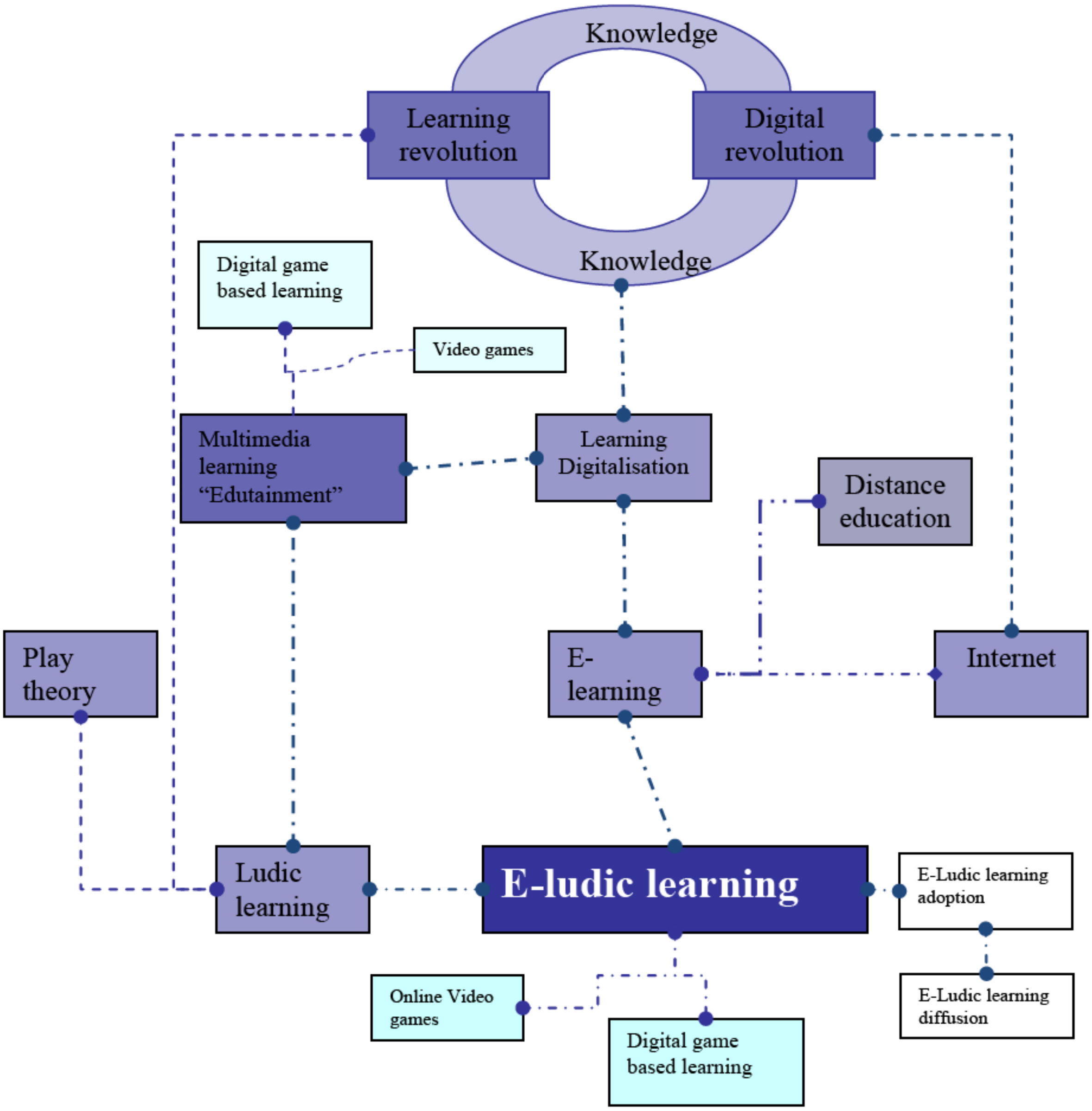


Figure 18. E-Ludic learning model evolution

CHAPTER V: METHODS

For the purposes of the thesis experiment I focused on Year One children. I selected the content based on the needs of the Mexican state of Puebla, principally, the need for a sound mathematical foundation in the early years of education (Miranda, personal communication, April 3, 2004). I then examined the curriculum for Year One students and discovered that basic addition (two single-digit operations) is taught in the early stages of year one, which was precisely when the experiment took place. I explained to the teacher responsible for the research participants that the aim of the experiment was to achieve automaticity in basic addition. She consented to this, acknowledging that her students needed to improve their basic arithmetic skills in order to succeed in more complex mathematical understanding down the track. The e-Ludic learning environment developed for this experiment followed the specifications discussed in the literature review. It included playfulness and involved learning content delivered in a distance education format. The experiment set-up represented an innovative and cost effective way of bringing knowledge to low ICT-aware regions.

5.1 THE EXPERIMENT

The thesis experiment was conducted remotely via Internet, e-mail, and webcam communication. Two research assistants were hired to implement the procedures. Both had clearances for working with children and experience in the use of ICT. I held email and audio web conversations with both assistants to debrief them on the project and their responsibilities. In order to perform the experiment an agreement was reached between SICOM and the author (see Appendices 4 and 6). I requested that SICOM provide me with a Regional Centre and a low ICT-aware school. They agreed to this, selecting the Tepeaca Regional Centre and Juan Escutia Primary school, in the municipality of Tepeaca, Puebla. Juan Escutia Primary is a school in a rural area which at the time of the study had no Internet access and only one computer available to Year One, Two, and Three users.

Having obtained the agreement with SICOM and the primary school, the next step was to gain an ethical clearance. Bond University regulations require that in order to conduct research with children, clearance must first be gained from the Bond University Human Resources Ethics Committee (BUHREC). I prepared my application based on the guidelines in the National Statement on Ethical Conduct in Human Research (NHRMC). The NHRMC (2007) states that researchers must identify and minimize any potential risks to the participants, obtain consent, and arrange databank safeguards. There are also special provisions for research conducted with minors, children in dependent relationships, the anonymity of participants, and for research conducted overseas. Logistical control and a familiarity with the area on the part of the research assistants guaranteed a low risk for the students participating in the experiment. They were careful to ensure that there were no hazards inside the SICOM Regional Centre that might jeopardise the students' safety. The research assistants also ensured that the bus driver was licensed and that the minibus was certified and in perfect running condition.

I explained in my BUHREC application that this was a research project involving children whose names and identities would remain confidential. No one was deceived about the nature of the research; the assistants just explained that it was about maths. There were no incentives for participating and I did not debrief anyone about the outcome. The school principal and the children's parents had to provide consent to having their children participate in the experiment in order for approval to be granted (see Appendix 5). It was clearly stipulated in a letter that participation was voluntary (see Appendices 2 and 3) and that signed consent was mandatory.

Parents were informed about the anonymity of the children and that records would be kept safe for five years and then destroyed. Parents were encouraged not to force their children to participate in the research and not to impose any form of punishment if they chose not to participate. Similar information was given to the group's teacher and the school principal. The research assistants delivered the necessary documentation. They travelled from Mexico City to Tepeaca, Puebla, for the project, while the author remained in Australia as the cost of travelling from Brisbane, Australia to Mexico City was prohibitive at the time.

Due to my research being undertaken overseas I was required to comply with additional requirements. I had to verify that the experiment and content of the program respected the local cultural context. I also had to make make sure that the research assistants understood the nature of ethical processes, both as they applied in Australia and in the local context of the experiment. At the time, SICOM and Juan Escutia Primary

School had no provisions relating to ethical research procedures. Consequently, I applied those of NHRMC.

5.2 The Setting

5.2.i Municipality of Tepeaca, Puebla

The Municipality of Tepeaca is one of 350 municipalities that compromise the state of Puebla, in Mexico's south-east region. It is located in the central area of the state and covers an area of 172 square km (Figure 19).

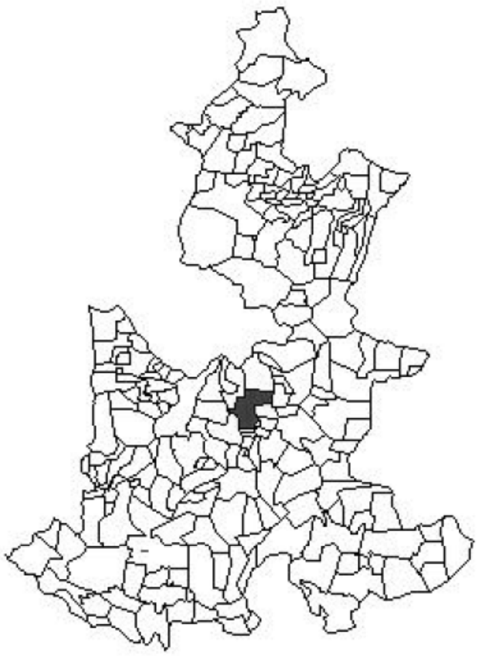


Figure 19. State of Puebla, Map of Mexico

The word Tepeaca comes from the Spanish alliteration of the word *tepeyac*. Tepeyac is made up of the Nahuatl words *tepetl*, meaning hill or stone and *yacat*, which means nose or tip. Together they suggest *on the tip of the hill or stone*. This name alludes to Tepeaca's geographic position. The municipality has 21 regions with Tepeaca as the capital. Only forty percent of the population is employed. The main industries in Tepeaca are agriculture, textiles, manufacturing, and tourism. Approximately forty percent of the workforce is involved in agriculture, farming, and fisheries; thirty-five percent are involved in tourism, services, and commerce; and twenty-two percent work in the textiles, mining, and construction sectors. By 1995 the municipality's population had reached 56,665 inhabitants, with 27, 595 men and 29,070 women, and an annual birth rate of three-point-six percent.

The region's development index is -0.459 which indicates a medium marginality index (SIMBAD, 2005). In regard to the social and communication services available to the population: one hundred percent have access to potable water; ninety-five percent have drainage systems; eighty percent have streets lights; eighty percent have access to public safety; and fifty percent have surfaced roads. The educational infrastructure includes 99 educational centres: 25 for preschool with 2,032 enrolled users; 37 for primary education with 11, 324 users; 20 for secondary school with 3,281 enrolments; 5 for high schools with 2,076 users; and 6 technical institutions with 253 enrolments.

Information from the National Institute of Geography and Informatics (INEGI) database relating to the 2000-2010 national census shows that the number of people who have a basic education in the municipatlity of Tepeaca is 6,836 (Table 9). This information is the most recent provided by INEGI regarding Tepeaca (SIMBAD, 2005).

Table 9. Municipality of Tepeaca basic indicators

Number of people who are illiterate	3,924
Number of people who are assisted with school	11,235
Number who have not completed a basic education	3,476
Number who have not completed secondary education	18,468
Number who have completed a tertiary education	1,136
Number who have not completed a tertiary education	21,460

Note (Digital Puebla)

This demographic information was provided by the SICOM Regional Centre in Tepeaca. They maintain their own database records from various sources that include the Tepeaca State Archives and the National Institute for Statistics and Geography (INEGI).

5.2.ii Juan Escutia Primary School

The Juan Escutia Primary School in Tepeaca was selected by SICOM and Digital Puebla personnel in response to my request for a low ICT-aware school to participate in the experiment. This particular school was offered due to its low economic class profile and the lack of access to ICTs for most of the students.

SICOM Regional Centre in Tepeaca

The SICOM Regional Centre in Tepeaca is located in the downtown area of the municipality. The Tepeaca Regional Centre shares the same goals as all SICOM Regional

Centres, namely to provide free ICT services to the community. The Centre provides three main facilities:

- Internet area: Most regional centres have 14 computers networked and connected to the Internet. Tepeaca has only 10 computers with a very slow dial-up Internet connection.
- Video and radio library: Most centres have around 1,000 educational video and radio programs. Tepeaca has 800 productions that can either be viewed in the same library or can be borrowed by registered users to be watched at home.
- Multipurpose classroom: This classroom has equipment for multimedia presentations. The room fits up to 100 people and is mainly used for academic purposes and for training provided by the Centre.

The Tepeaca Regional Centre assists an average of 2,000 users per month. Most of the users request Internet services. Additionally, the Centre has collaboration agreements with various educational institutions throughout the region to train users in the various aspects of ICT (Manjarrez, personal communication, April 24, 2004).

5.3 The Environment

The procedure that created the software environment “Learning - How to Add with Digital Puebla” (LHADP), targeting Year One students, was as follows:

- LHADP was hosted on a server in Australia named *Austarnet*.

- The interface was designed using FrontPage as the web editor in html and java script code.

- Two flash movies from Macromedia were developed and used.

- 10 java applets were developed and used to create a sophisticated interactivity.

Within the software environment, the java applets interacted with each other and with the JavaScript commands. The Flash movies displayed the introduction and the tutorial. The Java applets produced the ludic and learning elements in the client's computer. Flash from Adobe Macromedia and FrontPage from Office Suite software, were sponsored by Bond University, and the Java environment was downloaded from the Sun Microsystems website. This software is referred to as *Free and Open Source Software* (FOSS).

5.4 Learning Theory: Automaticity

The learning theory behind LHADP is *automaticity*. Research by Tournaki (2003) has shown that achieving automaticity following a period of practice is the goal of basic arithmetic instruction. The goal of the experimental session was therefore to develop automaticity among the users by their being exposed to LHADP in carrying out addition operations over a period of time. The length of practice to obtain automaticity varies depending on a particular user's learning capabilities. Arithmetic instruction requires automaticity in order to achieve higher learning capabilities, such as those required in understanding algebra and geometry (Cumming & Elkins, 1999). LHADP was designed to assist the user to achieve automaticity in arithmetic instruction by using ludic elements as learning tools.

5.5 Ludic Element: Random Number Generation (RNG)

Random Number Generation (RNG) is used as an engaging element in different applications, and operates as a ludic element inside games. The RNG element helps to keep students engaged while learning the content. During the experiment, each time a student clicked on the *juega* (play) button, a random number of balls were generated (see Interface below). The user had to continue in order to gain the required knowledge and as they continued generating numbers they experienced a sense of engagement and flow.

5.5.i Content: Arithmetic Instruction for Year One Students; Addition

LHADP content was defined based on the Mexican and the state of Puebla's curricula for addition instruction in Year One. The curricula suggested using one-digit numbers and quantifiable objects so that a counting relationship could be created in a child's mind. To accelerate Year One learning, students should be able to conceptualise the meaning of addition with one-digit numbers and to solve arithmetic operations (Miranda, personal communication, 3 April 2004).

5.6 The Interface

The interface commences with an introduction from a Flash movie and by using two adjacent buttons: *estrategia* (strategy) and *juega* (play). The Flash movie is embedded as an object file in FrontPage (Figure 20). The user must select one of the options to continue with the environment. The Flash movie displays a brief animated introduction using a child's voice-over message. The message says *Bienvenido a Aprendiendo a Sumar con Puebla Digital* (Welcome to Learning How to Add with Digital Puebla).

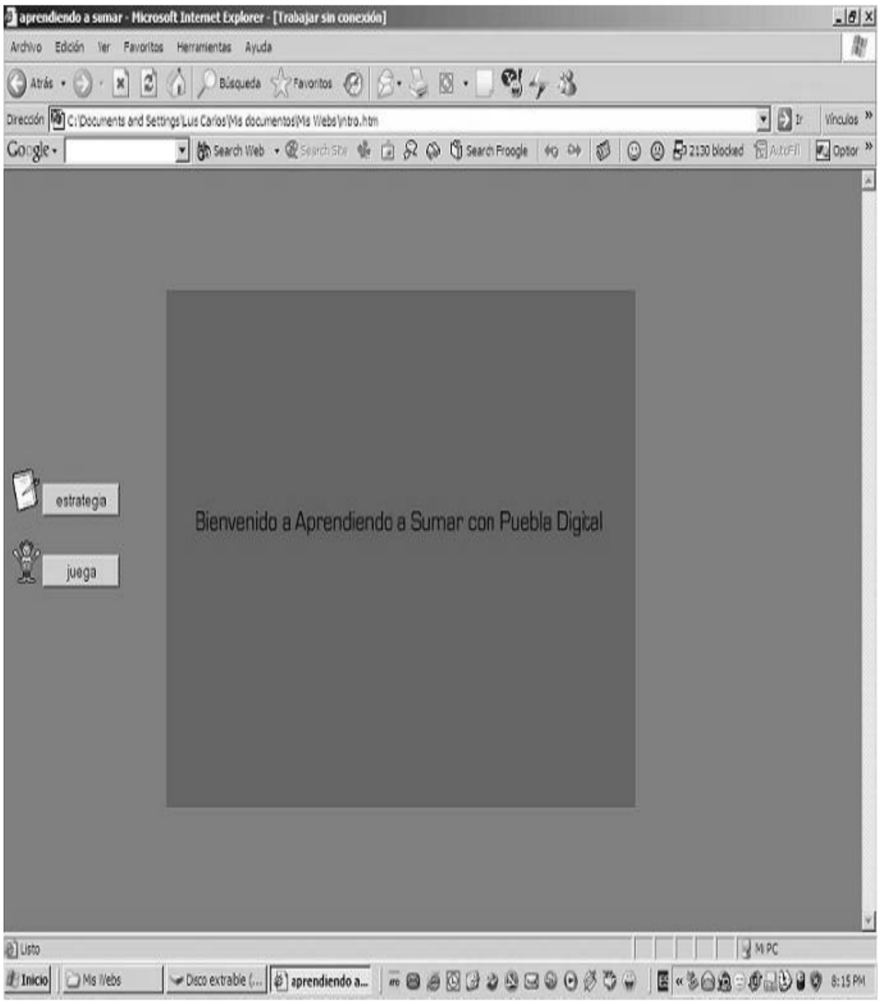


Figure 20. LHADP Introduction interface

If the user clicks on the strategy button he/she is directed to the tutorial page. The tutorial page was designed by using Flash from Macromedia software. The Flash animation has a child's voice-over which narrates the animation regarding addition instruction. The tutorial teaches the user how to add by showing the addition (+) and equal (=) symbols first. The "+" and "=" symbols fade out within the Flash movie as the voice-over defines 'addition' (Figure 21).

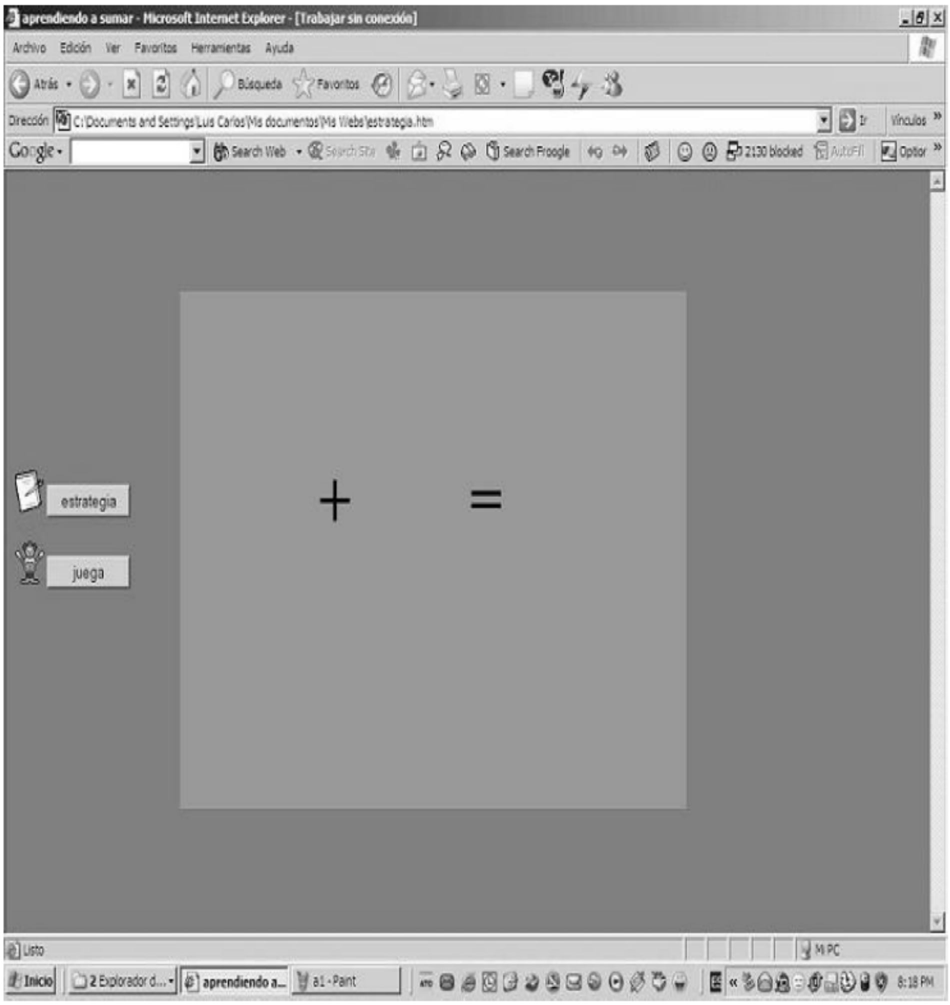


Figure 21. LHADP Addition and Equality Signs

Next, both the “+” and “=” symbols claim their fixed positions on the screen and a series of black dots pop up and form two columns. The number of the black dots is limited to five per column. As seen in Figure 24, the black dots line up vertically to the right and left side of the “+” symbol. As the dots appear, a corresponding number will be displayed at the right hand side indicating the sequential place of each dot (Figure 22).

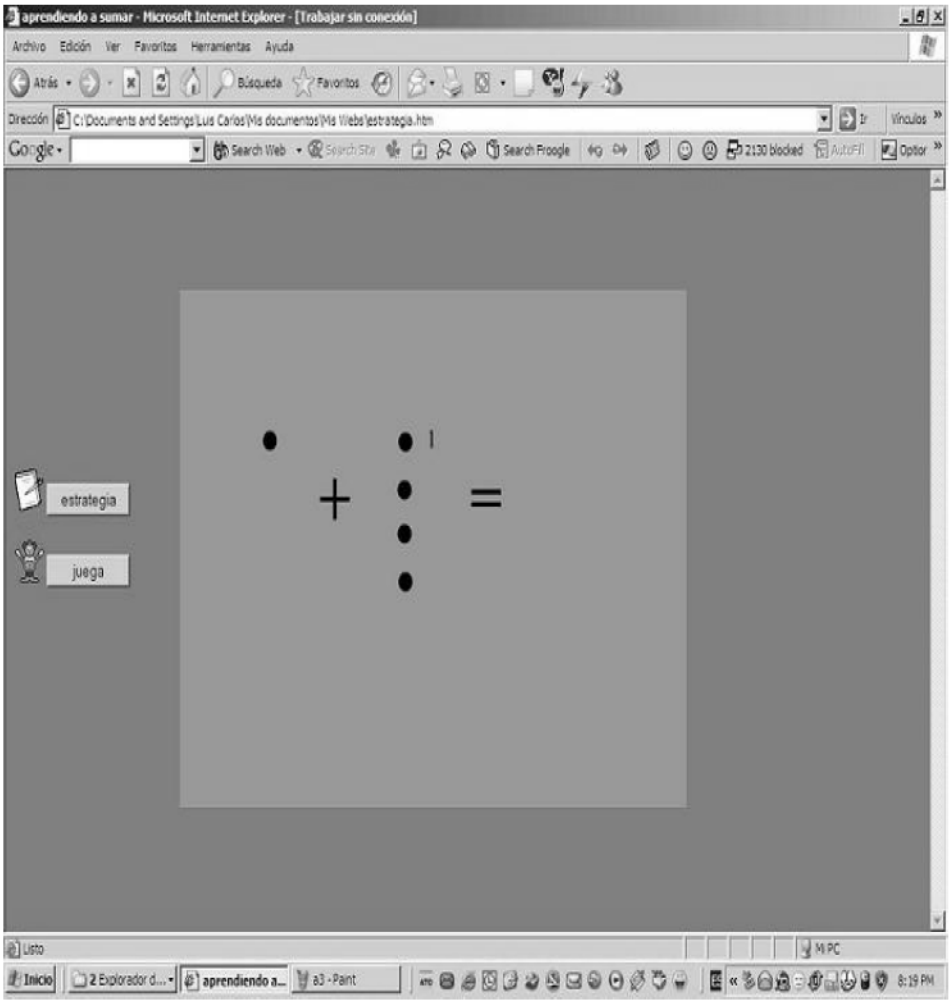


Figure 22. LHADP black dots

The numbers pop up simultaneously with each black dot. Figure 23 shows the number five (5) adjacent to the ball in the left column. The numbers one (1), two (2), three (3), and four (4) have already appeared as each previous dot popped up. By using this technique, the user associates the counting process with a numeral by viewing the mathematical concept itself. When five dots have finished showing up simultaneously a number in one column, the next dots and numbers appear in the other column according to the same process.

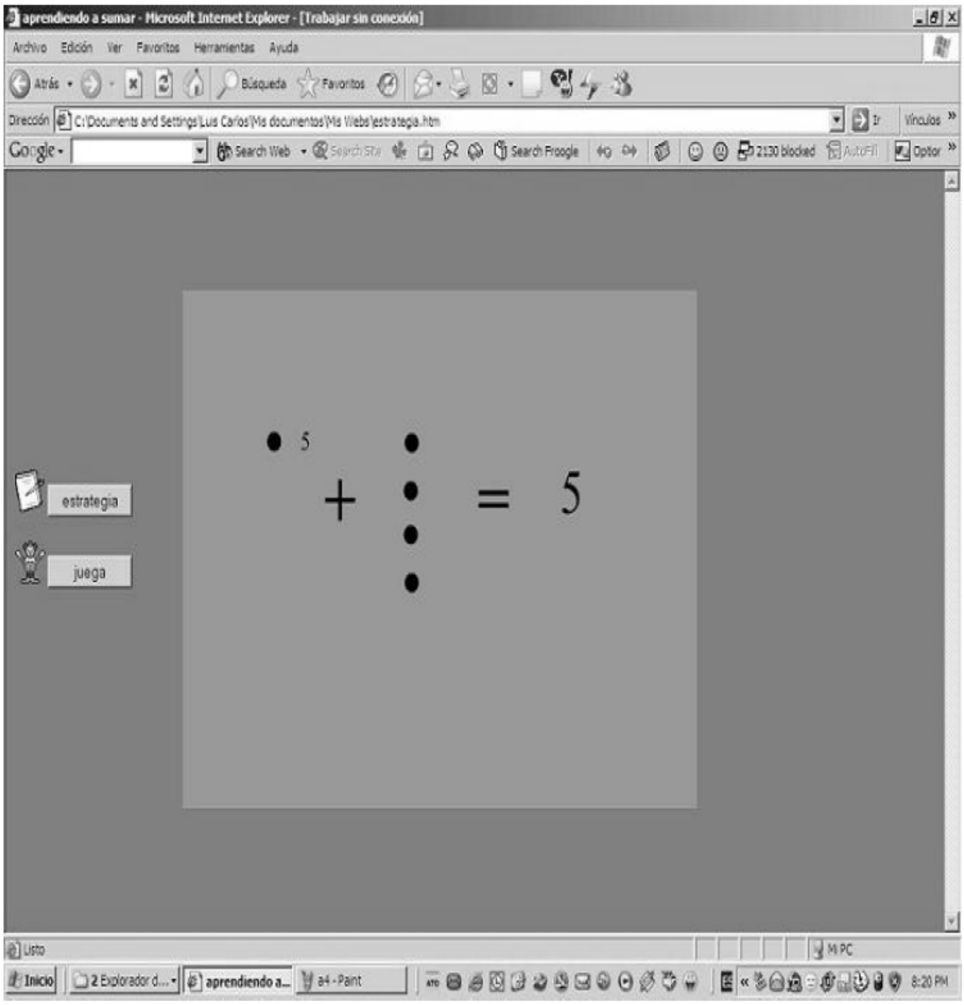


Figure 23. LHADP black dots and numbers

Four numbers (1, 2, 3 and 4) have already shown up sequentially with each dot in the right column, which automatically creates the next numerical figure in the left column as number five (5). When this process is complete a numeral will appear at the right hand side of the equal (=) symbol representing the answer to the equation. In the example given in Figure (25) the figure five (5) appears at the right side of the equal (=) symbol indicating that the four (4) black dots in the right column plus (+) one (1) black dot in the left column equals (=) five (5). At this point it is expected that the user already knows what each symbol represents, that is, plus (+) and equal (=).

Once the addition operation is fixed in its horizontal position in the Flash movie, the black dots slowly transform into their corresponding numerals. For example, in Figure 24 the black dots transform into numbers one (1) and five (5). Then, at the right side of the equal (=) symbol number six (6) appears as the product of adding up numbers one (1) and five (5). Using this technique the user can create an association between the black dots and the quantity they represent, and the addition thereof.

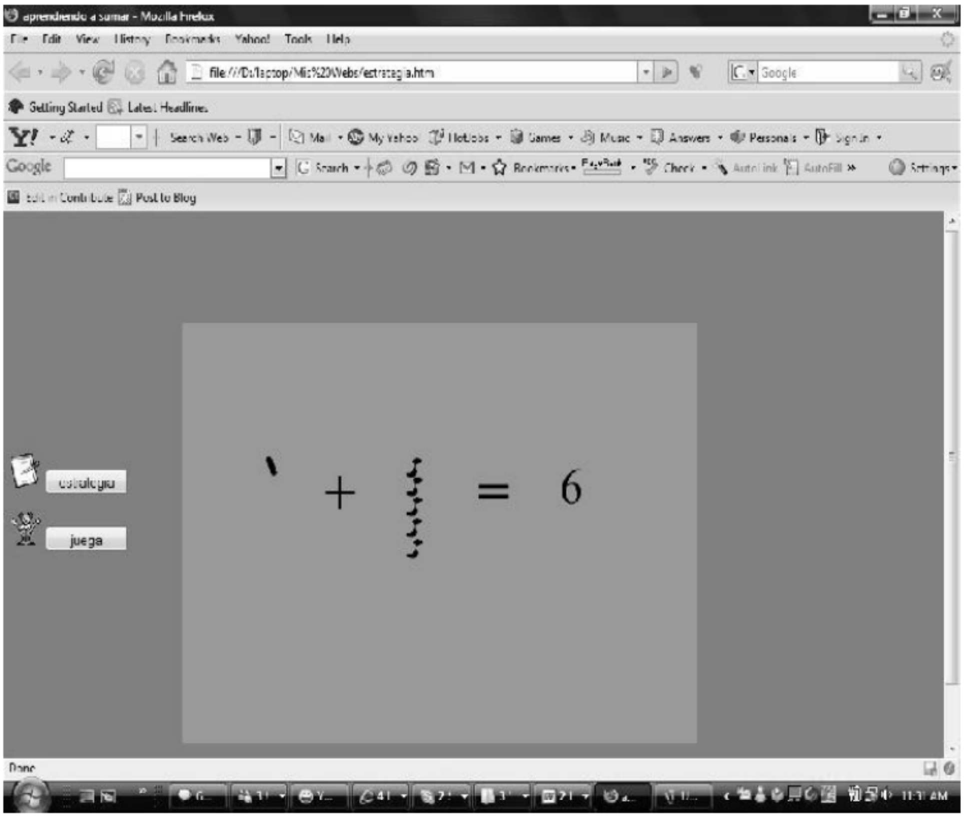


Figure 24. LHADP black dots transform into numbers

Once all the dots have been transformed into a corresponding numeral the whole addition operation becomes fixed on the screen. For example, in Figure 25 we see "1+5=6".

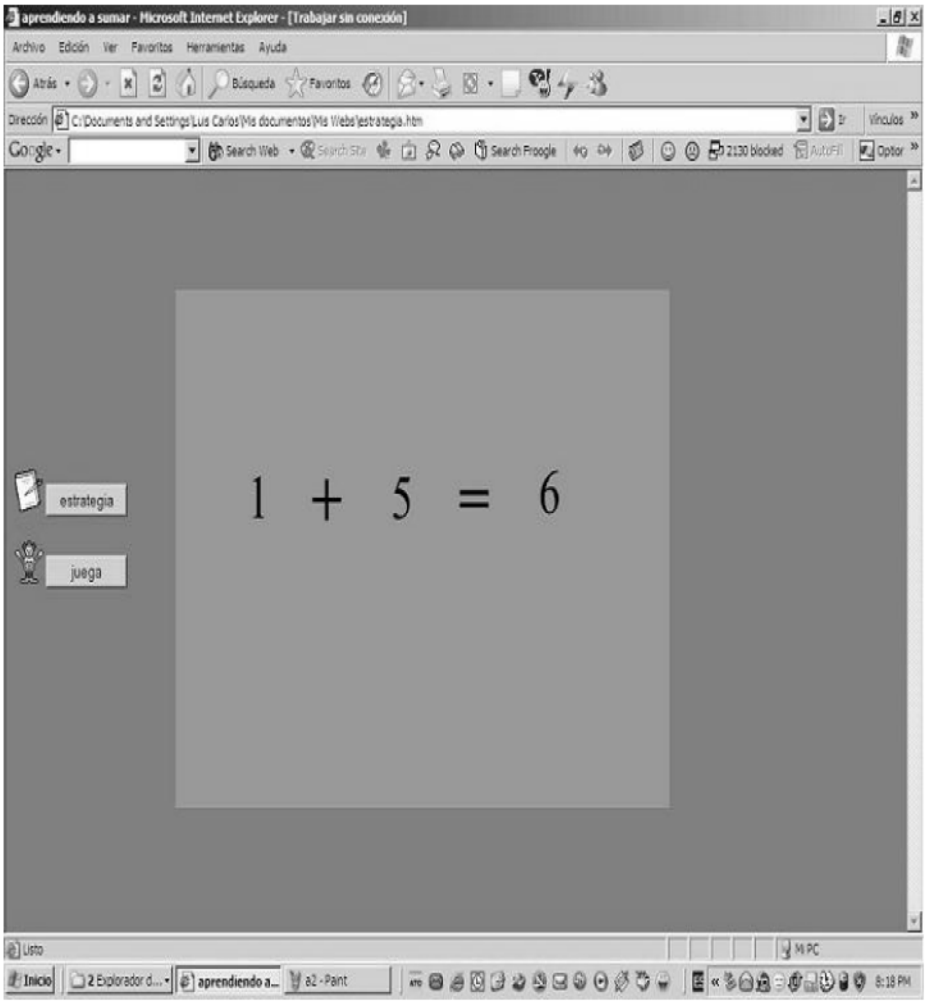


Figure 25. LHADP addition with numbers

The tutorial runs through the same dynamic process, displaying a total of four possible combinations of sums and by using one digit additions as follows:

1 + 4 = 5

1 + 5 = 6

4 + 4 = 8

2 + 3 = 5

After viewing the tutorial the user may advance to the next stage by clicking the *juega* (play) button. The interface displays a new design (Figure 26).

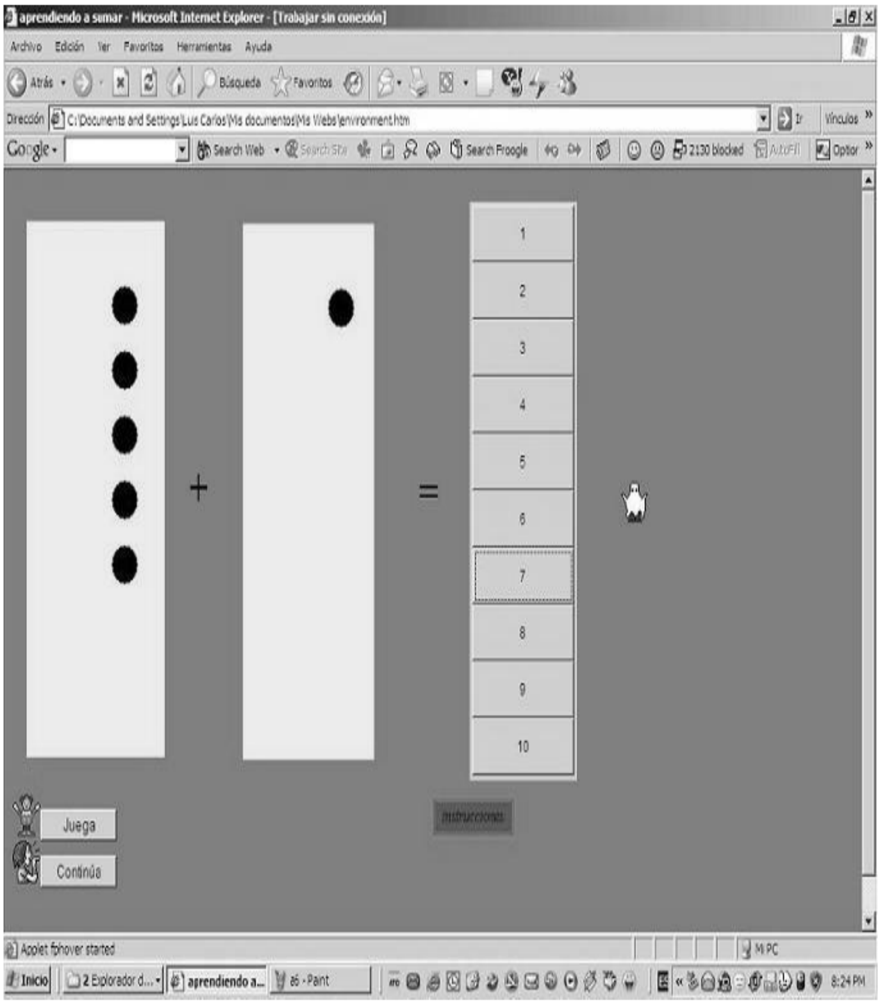


Figure 26. LHADP Play Button interface

The play interface integrates Java applets as part of the design and the program's functionality. The Java applets provide the RNG that interact with the JavaScript-based buttons. Before commencing, the user should listen to the instructions by clicking on the green button that is positioned under the numbered buttons. To initiate play, the user must click the *juega* button which generates two columns of black dots. Each set of dots is arranged in a vertical position inside a yellow rectangle as seen in Figure 27. The number of dots is generated through an RNG process (see RNG as a ludic element). The number of dots should not exceed five per column in order to keep the number ten as the maximum possible result of the addition operation. The user is instructed to observe and count the dots in the two columns inside each of the yellow rectangles. He/she must then click on the button that selects the number representing the correct total. If the user selects the correct total a superhero icon is displayed at the right side of the answer buttons as seen in Figure 27.

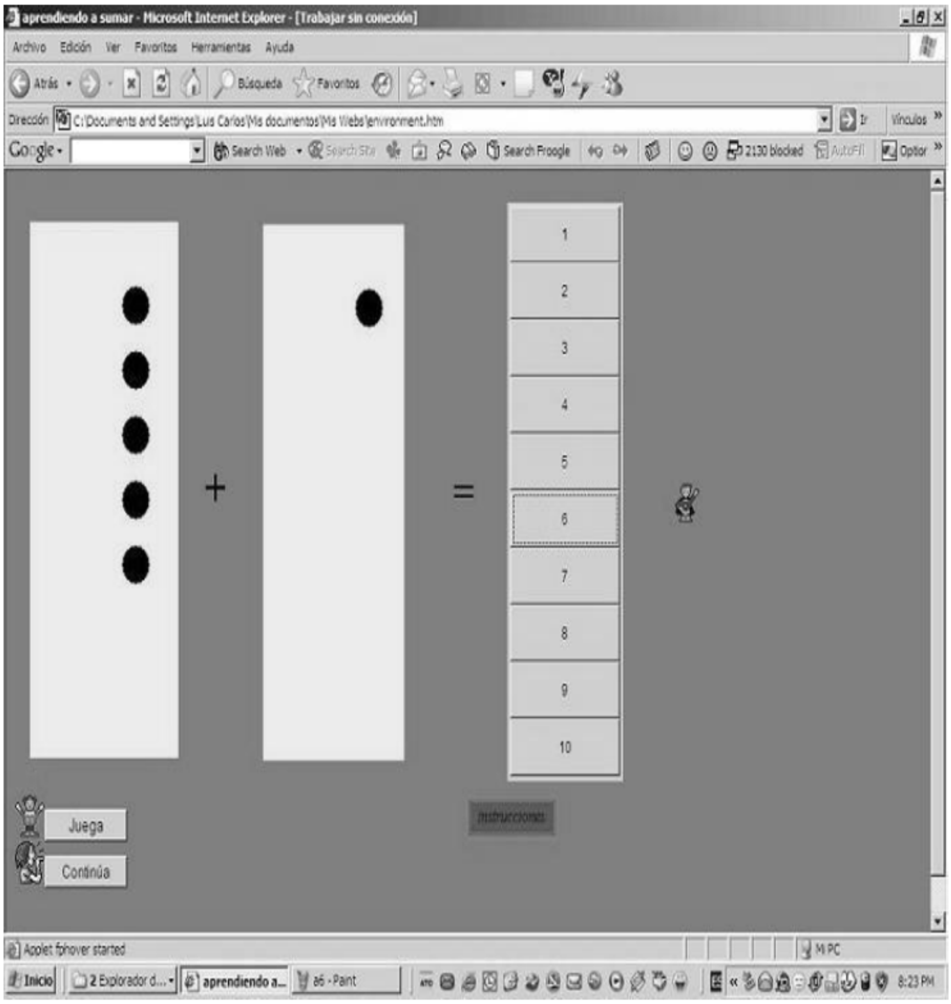


Figure 27. LHADP addition and equality signs

After the correct total has been selected and the superhero is displayed, the user must then click on the "continua" (continue) button. A similar interface will appear. However, instead of ten buttons it will display a text box next to the equal sign (=) with the legend *Anota la Respuesta* (Input the Answer) above it. If the user types in the correct answer the same superhero displays; otherwise a white ghost icon pops up (Figure 28).

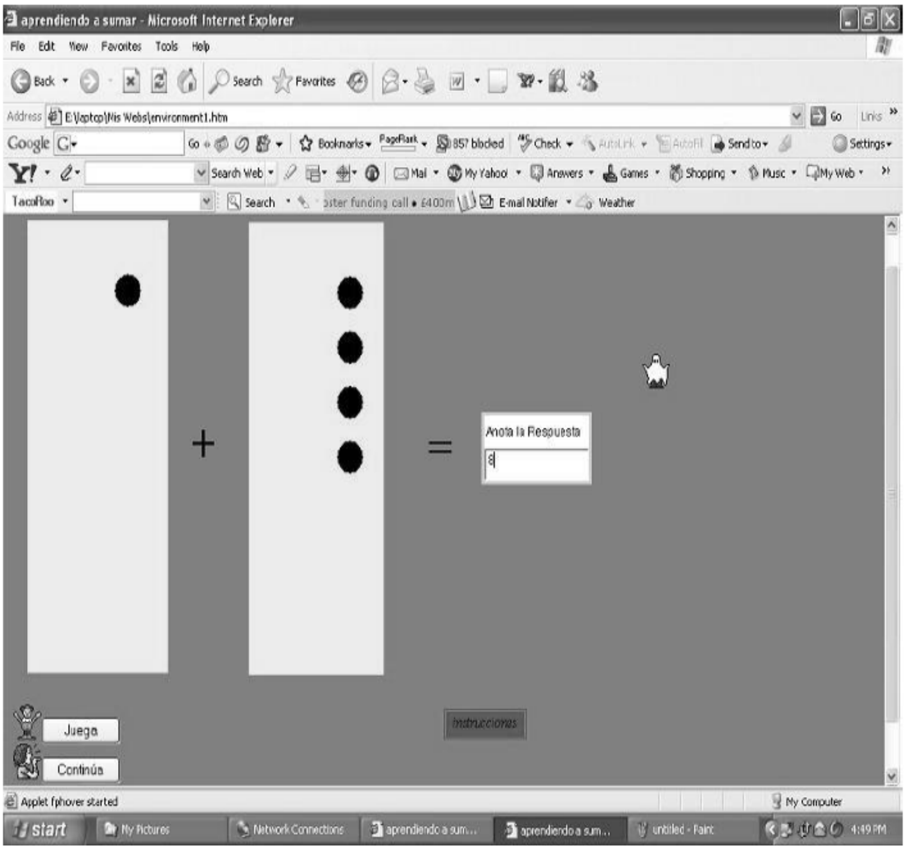


Figure 28. LHADP White Ghost

After playing this interface the user must click the *continua* (continue) button again. An interface similar to that of the first one will appear, and only after the *juega* button is clicked will any difference be observed. The difference is that this time the yellow rectangles will show real numerical figures instead of black dots (Figure 29).

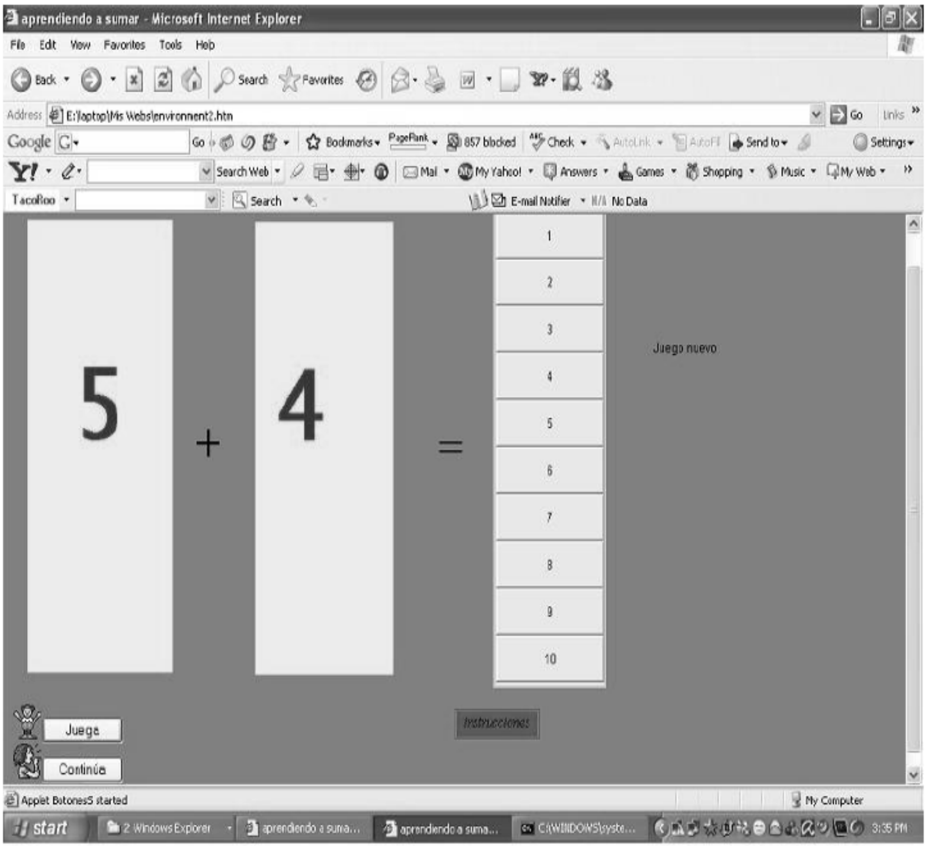


Figure 29. LHADP Numeric Figures

Following a set of instructions, the user must then repeat the same process as performed when using the first interface. The new interface is similar to the second interface (interface three and one display black dots): instead of black dots the screen shows Arabic numbers inside the yellow rectangles. In addition, interface four has two more buttons *Otra vez* (play again) and *fin* (end). The new buttons give the user the option to play the game again or to finish it. The *play again* option is included in the last interface so that the user's skill may progress throughout the tutorial (Figure 30).

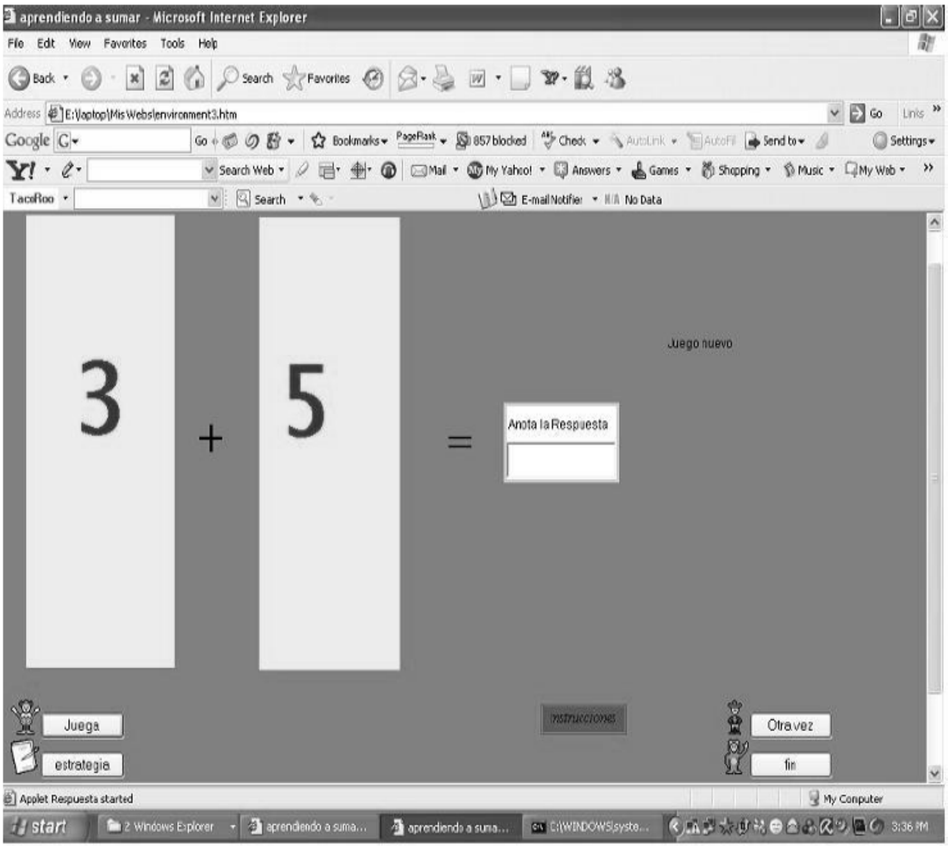


Figure 30. LHADP Final interface

5.7 The Experiment Design

The project experiment was based on the experimental designs for arithmetic instruction involving automaticity, software material, and Analysis of Covariance ANCOVA, in educational research undertaken by Tournaky (2003), Moreno and Mayer (1999), Todman and Dugard (1995), and Din and Calao (2001). Each of these applied pre-test and post-test instruments in their research (Figure 31).

Exp. Addition	R	O_1 Pre-test: efficiency and e-literacy	$X_{e\text{-}ludic}$	O2 Post-test: efficiency and e-literacy
e-ludic learning environm ent for learning how to add up	N=40	O_1 Pre-test: efficiency and e-literacy	X_{f2f}	O_2 Post-test: efficiency and e-literacy

Figure 31. Pre-test and post-test

Pre- and post-test methodologies are most suitable for education research when gain scores are involved (Mok & Wheldall, 1995). The pre-test is used as a covariate in order to control time exposure. Four instruments were used in the experiment: two pre-tests and two post-tests, each with identical sets of items (Tournaky, 2003) for arithmetic instruction and for ICT-awareness. For maths each pre-test and post-test had a set of ten single-digit sums (see Appendix 7). For ICT-awareness I typed two sets of 10 questions, one for pre-tests and one for post-tests (Appendix 8). Each sum or question had a value of 10 points if answered correctly. No points were obtained if a sum or question was answered incorrectly.

5.8 Variables

The first step in performing statistical analysis is to define the variables and formulas involved (Garson, 2004). The independent variable was the e-Ludic learning condition which meant exposure to the environment. There were four dependent variables involved in the experiment: *accuracy*, *answer*, *latency, efficiency*, and *ICT-awareness*. Accuracy, latency, answer, and ICT-awareness values were directly derived from pre- and post-test results. Efficiency values were obtained from a formula that combined accuracy, answer, and latency values. These four dependent variables are defined as follows:

- Accuracy: Indicates the number of questions correctly answered in the pre-test and post-test. Accuracy values were allocated on a 0 to 100 scale.

- Answer: Indicates the number of questions answered (correctly or incorrectly) in the pre-test and post-test. Answer values were also allocated on a 0 to 100 scale.

- Latency: Indicates the time taken to answer the pre- and post-test questions and is measured in seconds. Latency indirectly affected efficiency as a measurement according to the "Dominguez Factor" (described below). The higher the values for the latency score were, the proportionately lower the values for the efficiency variable became.

- Efficiency: The more questions answered correctly the greater the efficiency of the results. Efficiency is a measure derived from the latency and accuracy values. It was obtained using a formula developed for the thesis and named the "Dominguez Factor". Efficiency values were not expressed as percentages in order to avoid confusion with answer and accuracy values. Instead, efficiency was a composite index dependent upon answer, accuracy, and latency. For example, if a user answered all the questions, but none were correct, his efficiency was zero. However, if he/she answered every question, and all were correct, his efficiency then depended on the amount of time taken to finish the test.

- ICT- awareness: Indicates the knowledge gained in relation to ICT concepts regarding the academic year of the users.

5.9 Formulas

1) **Latency** = [time to $\underbrace{\text{answer}}_{\text{Unit in seconds}}$ questions]

2) **Accuracy** = 10*[(number of questions correctly answered)]

3) **Answer** = 10*[(number of questions answered)]

4) **ICT- awareness** = 10*[(number of questions correctly answered)]

Dominguez’s Factor

5) **Efficiency** = [(number of questions correctly answered) ∕ (number of questions)] [(number of questions answered) ∕ (number of questions)] [1 ∕ t] = [answer ∕ 10] [accuracy ∕ 10] [1 ∕ latency]

5.10 Participants

The experiment was conducted from March to September, 2004. It took place in the SICOM-Digital Puebla Regional Centre in Tepeaca, Puebla. All sessions were video recorded by the research assistants. Initially, 46 Year One students were randomly selected from a pool of 180 to participate in the sessions. However, as a result of applying a pre-test exam only 40 users were selected. This was due to six out of the initial 46 users obtaining scores that fell into an outlier category. The 40 selected students belonged to similar economic and social backgrounds. Most of their fathers worked as tradesmen and most of their mothers did housekeeping jobs. Eighteen were girls and 22 were boys, all aged between seven and eight. Their parents indicated that they had no computer or Internet access at home and that they used television or manual games as entertainment.

Two groups of 20 users were randomly assigned by using a coin-toss method. Twenty users were allocated to the control group while the other 20 were allocated to the experimental group. The control group had eight girls and 12 boys while the experimental group had 10 girls and 10 boys. Eleven seven-years-olds were part of the control group and 12 seven-years-olds were part of the experimental group. The remaining 17 children were eight-year-olds, with eight in the experimental group and nine in the control group. In multimedia research in the field of education it is common to have small samples (Mann, Newhouse, Pagram, Campbell & Schulz, 2002), and the above samples provided sufficient statistical power as shown in the next chapter.

Each morning of the project the two research assistants met the participants at the entrance of Juan Escutia Primary School. They were then transported to the Regional Centre, which involved a 10 minute trip. The network was set up and the software tested before the commencement of each session. Although we had intended to have 10 computers running, the network presented problems that were unable to be overcome. Internet Explorer could not run the application because Java Runtime Environment was not installed in the client computer. As it would have taken a number of days to rectify the problem, we decided to use Netscape as a browser. However, only five computers were able to run the application properly. The main problem lay with the systems operating model, and eventually those computers with Windows XP proved to be the most suitable for use.

Once the computers had been prepared, the research assistants were trained via web-cam. First, they were familiarised with the software features and the content involved was explained to them. They were then instructed in the type of feedback that needed to be provided to users who had difficulty understanding the environment. We established that feedback should be provided regarding the software's use only, and not about the content material. The research assistants were to provide the users with a series of initial operational instructions (Appendix 9). I created operational instructions as part of the experiment setup so that the children could have an understanding of the program and the experiment itself. These instructions never referred to the learning content delivered in a distance mode. The learning content was delivered through an online tutorial that was part of the environment. The research assitants were to provide immediate answers to any questions that arose in relation to the operational instructions. The research assistant training sessions inside the Tepeaca Regional Centre lasted two days and included how to apply pre-test and post-test examinations. I also explained to the assistants how to record

Playfulness (Howard, 2002) and Level of Knowledge (Baumgartner, 2001). We commenced the experiment sessions as soon as the research assistants were prepared.

4.11 THE SESSIONS

4.11.i Session One

Friday, September 3, 2004: Session One involved two pre-test questionnaires being presented to the 40 users in Juan Escutia Primary school; one questionnaire for arithmetic instruction and one for ICT-awareness. One research assistant recorded the session on video while the other assistant read the instructions on how to take the test to the users. The participants were instructed to indicate that they had finished answering the questions by raising their hand. The moment a participant had finished and had their hand up, the research assistant headed to his/her place and marked the time it had taken to complete the test. Participants were instructed not to take longer than 10 minutes to answer the pre-test questionnaires for the session. This session lasted 25 minutes with none of the participants taking more than 10 minutes to answer the pre-test questionnaires.

4.11.ii Session Two

Monday, September 6: Session Two in the SICOM Regional Centre involved the group of 20 students in the Internet area (experimental group), with the remaining 20 at school (control group). The control group attended regular classes while those in the experimental group were exposed to the software. We divided the experimental group into four sub-groups due to the limited number of usable computers. Each sub-group of five children was randomly assigned by using the coin-toss method. They were given 20 minutes in total to play in the e-Ludic learning environment. While one sub-group played in the e-Ludic environment, the remaining three sub-groups were in the multipurpose room watching a multimedia presentation about animal life. All the users were rotated throughout the sessions on successive days so that no single user remained in the same sub-group.

Before starting the session a research assistant gave brief instructions on how to use the software (Appendix 9). The assistant explained how to surf through the software, and how to use each of the relevant buttons and input devices on the computer. The assistant also explained to the users that the goal was to first observe the tutorial, and then to play the game. The assistant also discussed the subject of ICT-awareness. All users in the experimental group started viewing the tutorial first. Surprisingly, there were no questions regarding the software. At the same time not a single user concluded the environment. The research assistant observed early adoption of the software by the students. They indicated they wanted to play more.

5.11.iii Session Three

Wednesday, September 8: Session Three was conducted in the same manner as Session Two. The control group remained at school and attended regular classes while the experimental group participated in the e-Ludic learning lessons. On this occasion, the research assistant instructed the participants to continue playing where they had left off in their previous session. Some questions emerged from the users, principally regarding the use of the *instructions* button. The concern of the participants related to how many times they could listen to the instructions. The research assistant explained that the instructions could be repeated as many times as necessary until the participants felt comfortable. Some users indicated when they had finished the whole game.

5.11.iv Session Four

Friday, September 10: Session Four followed the same logistics as the previous sessions. All experimental group participants indicated that they knew how to use the software. The research assistant recorded an improvement in the users' fluency in interacting with the software. The assistant indicated that in the first five minutes every user had completed every phase of the environment. At the end of the session every user asked for more time to keep on playing.

5.11.v Session Five

Monday, September 13: Session Five was the last practical session, and had the same dynamics as each of the previous sessions. All the experimental group participants were familiar with the software and there were no questions. The research assistant reported a state of flow in all the users. At the conclusion of the session, all the users wanted to continue playing. The research assistant asked the users if they had enjoyed the sessions and received an overwhelming *yes* as the answer.

5.11.vi Session Six

Tuesday, September 14: Session Six involved two post-test questionnaires being answered by the 40 participants in Juan Escutia Primary for arithmetic instruction and ICT-awareness. The same questionnaires (Appendices 7 and 8) completed in the pre-test were presented at the post-test examination of the 40 participants. This session was identical in logistics to the pre-test session. One of the research assistants timed the participants' answers with no more than 10 minutes allowed to complete the questionnaire.

5.11.vii Follow-up

From September 16 to October 30, 2004, the author and a research assistant developed a DVD and video of the sessions in order to have a record of the experiment.

On November 12, 2004, the records and results were sent via mail to the author's home address in Queensland, Australia.

CHAPTER VI: RESULTS

6.1 DESCRIPTIVE STATISTICS FOR MATHEMATICAL INSTRUCTION

Initial descriptive statistical analysis has been used in similar research (Din & Calao, 2001; Tournaky, 2003), and was carried out in this study using Statistical Package for the Social Sciences software version 14 (SPSS), to determine whether there had been an increase in the raw pre-test and post-test scores. The treatment groups' pre-test and post-test scores and the control groups' pre-test and post-test scores were compared. Scores were then divided based on each of the dependent variables: accuracy, answer, latency, efficiency, and ICT-awareness. Group variation analysis was deeply explored using inferential statistics, particularly Analysis of Covariance (ANCOVA).

6.1.i Accuracy

Users in the treatment group showed a 24 point difference on a 1 to 100 scale between their post-test mean scores (*M*= 46.00, *SD*= 16.983) and their pre-test mean scores (*M*=

22.00, *SD*= 12.814). The control group showed no relevant variation in the post-test (*M*= 23.50, *SD*= 10.894), pre-test (*M*= 21.50, *SD*= 11.367) comparison (see Table 10).

Table 10. Means and standard deviation for accuracy

Group		Post-acc	Pre-acc
Control	N	20	20
	Mean	23.50	21.50
	Std. Deviation	10.894	11.367
Experimental	N	20	20
	Mean	46.00	22.00
	Std. Deviation	16.983	12.814

The experimental treatment group showed a large difference between pre-test and post-test scores, while there was little difference between pre-test and post-test scores for the control group (Figure 32).

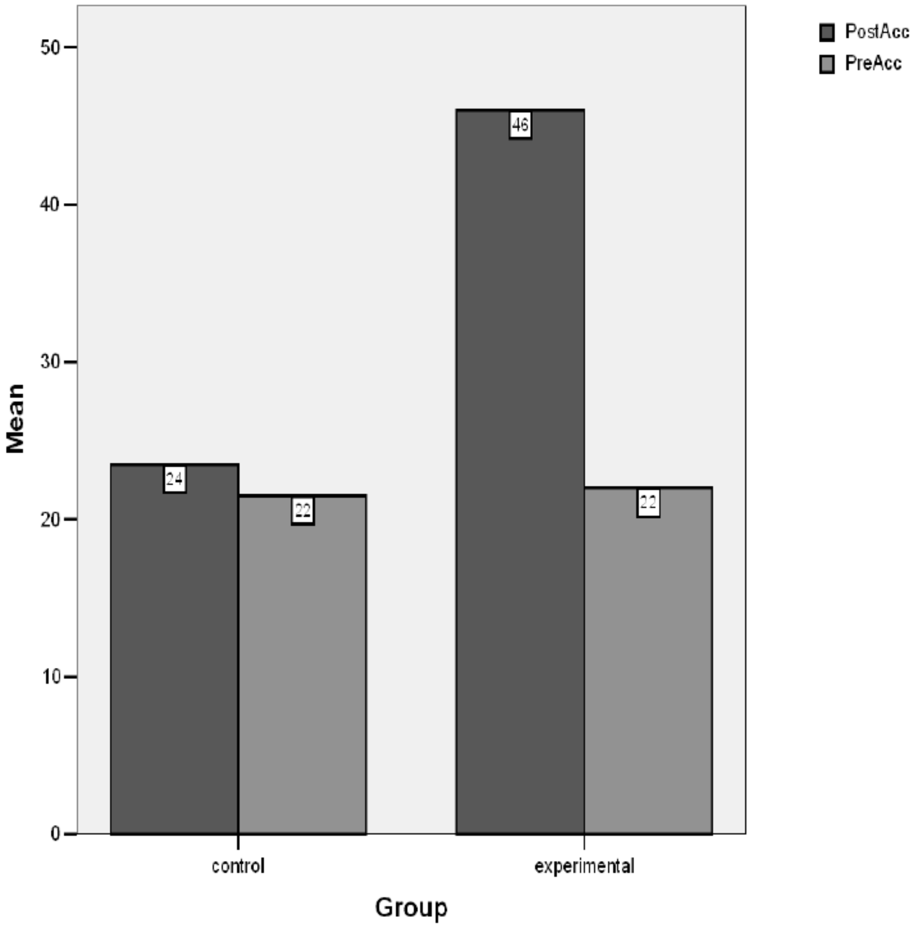


Figure 32. Accuracy means

6.1.ii Answer

Users in the experimental group showed a 4.5 point difference on a 1 to 100 scale between their post-test mean scores (*M* = 98.00, *SD* = 4.104) and their pre-test mean scores (*M* = 93.50, *SD*= 8.127). The control group showed a 3.0 point variation on a 1 to 100 scale between their post-test mean scores (*M*= 95.50, *SD*= 5.104) and their pre-test mean scores (*M*= 92.50, *SD*= 9.105) (see Table 11).

Table 11. Means and standard deviation for answer

Group		Post-answer	Pre-answer
Control	N	20	20
	Mean	95.50	92.50
	Std. Deviation	5.104	9.105
Experimental	N	20	20
	Mean	98.00	93.50
	Std. Deviation	4.104	8.127

Answer scores in the control and treatment groups showed slight increases in the post-test scores (Figure 33).

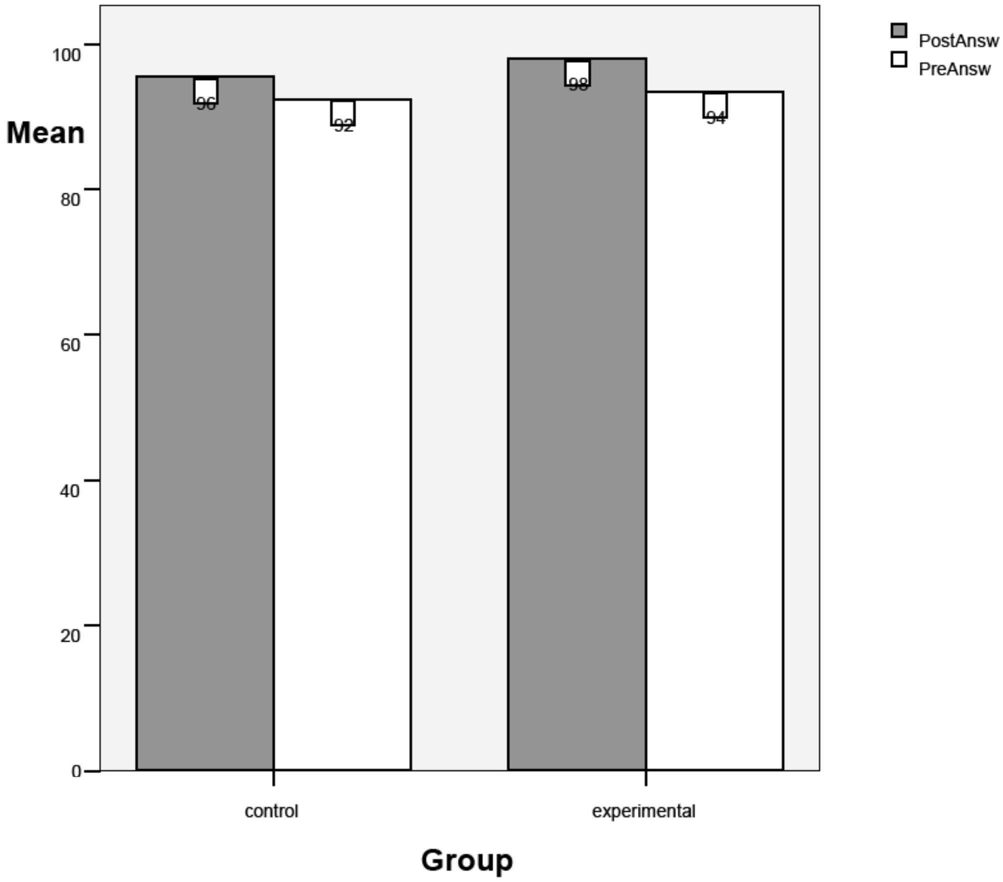


Figure 33. Answer means

6.1.iii Latency

Users in the experimental group showed a 16.48 point difference on a 1 to 100 scale between their post-test mean scores (*M*= 276.65, *SD*= 14.748) and their pre-test mean scores (*M*= 293.13, *SD*= 5.562). The control group showed a 3.0 point variation between their post-test mean scores (*M*= 290.10, *SD*= 6.223) and their pre-test mean scores (*M*= 293.05, *SD*= 6.057) (see Table 12).

Table 12. Means and Standard Deviation for Latency

Group		Post-latency	Pre-latency
Control	N	20	20
	Mean	290.10	293.05
	Std. Deviation	6.223	6.057
Experimental	N	20	20
	Mean	263.20	293.20
	Std. Deviation	5.187	5.177

Latency mean scores in the control group showed slight decreases in the post-test mean scores (Figure 34). The experimental group showed a larger decrease in the post-test mean scores. This indicated that the users in the experimental group were faster on average in the post-test.

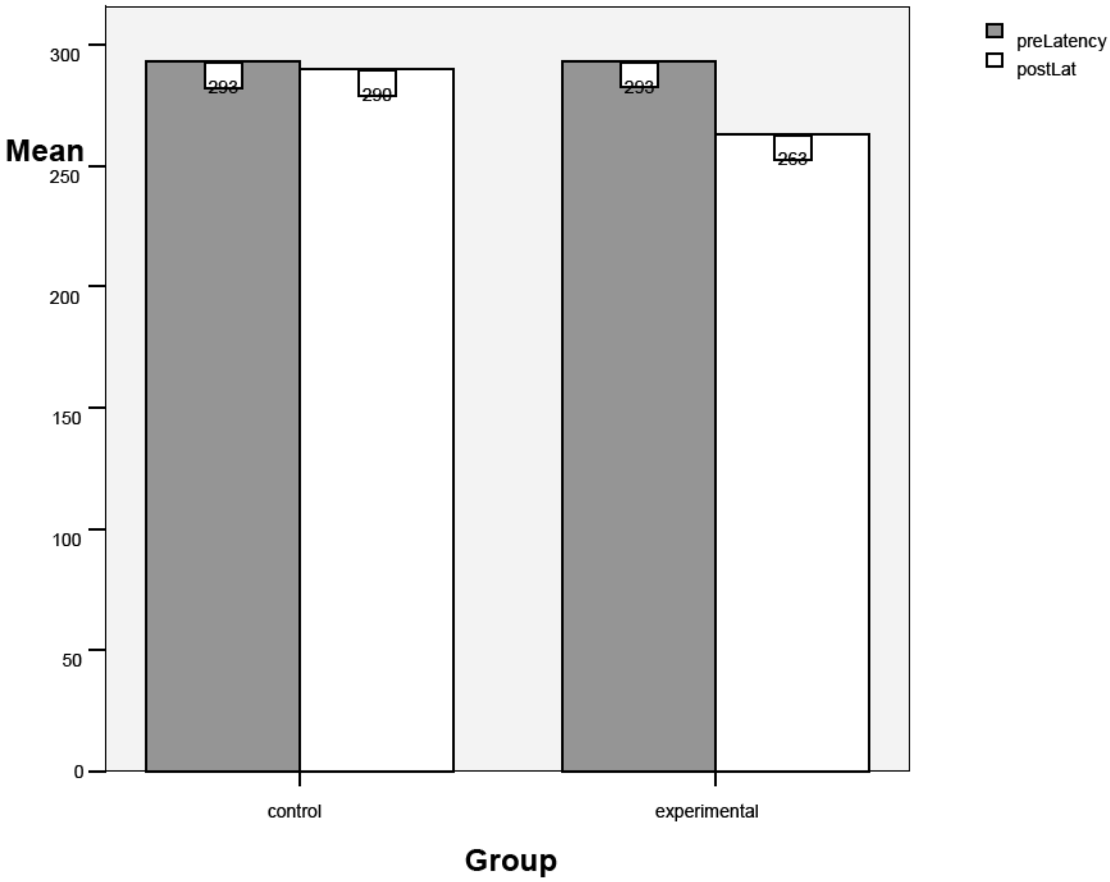


Figure 34. Latency means

6.1.iv Efficiency

Users in the experimental group showed a 6.04 point difference between their post-test mean scores (*M*= 10.27, *SD*= 3.85) and their pre-test mean scores (*M*= 4.23, *SD*= 2.5). The control group showed no variation in the post-test (*M*= 4.54, *SD*= 2.11) pre-test (*M*= 4.06, *SD*= 2.19) comparison (see Table 13).

Table 13. Means and standard deviation for efficiency

Group		Post-effic	Pre-effic
Control	N	20	20
	Mean	4.546800	4.060400
	Std. Deviation	2.1188898	2.1944520
Experiment	N	20	20
	Mean	10.277600	4.238000
	Std. Deviation	3.8542644	2.5068706

As with the results for accuracy, a comparison of the pre-test and post-test scores of the treatment group for efficiency showed a large increase. Meanwhile, the control group mean in the post-test and pre-test remained very similar (Figure 35).

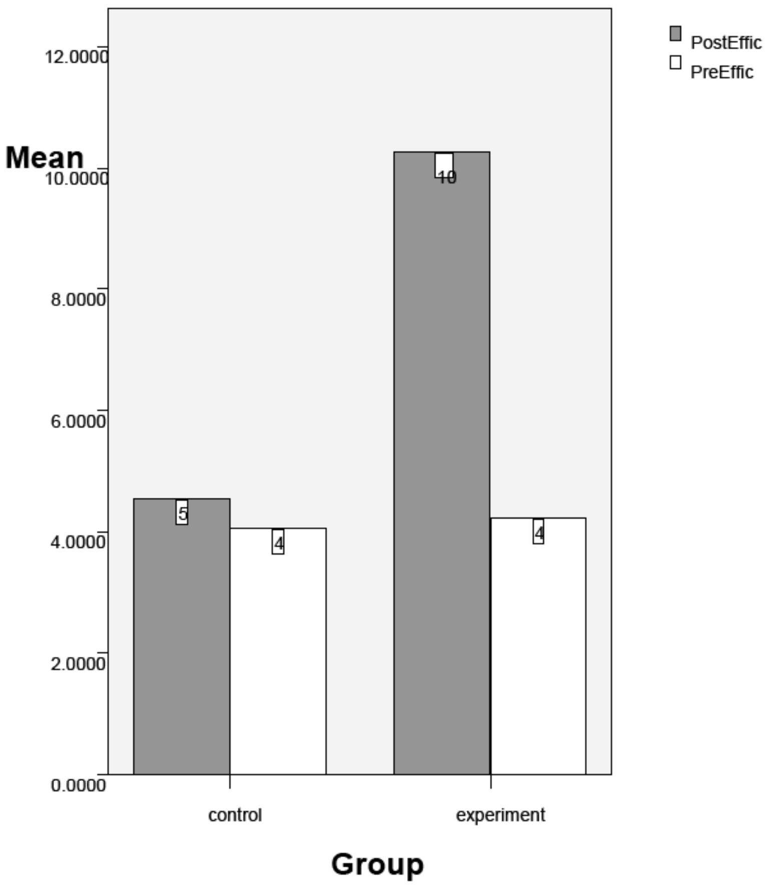


Figure 35. Efficiency means

6.2 Analysis of Covariance and Effect Sizes for Mathematical Instruction

Analysis of Covariance (ANCOVA) is a powerful tool for the analysis of pre- and post-test experimental designs, when chance differences can arise in the allocation of subjects within the treatment conditions (Keppel & Zedeck, 1989; Todman & Dugard, 1995). In this case, pre-test scores operate as covariates in order to compensate for any pre-existing differences in the control and experimental group. ANCOVA removes or controls the "…Y variability (dependent variable) that is related to the covariate and then tests how much of the remaining Y (dependent variable) variability can be explained by the treatment condition" (Keppel and Zedeck, 1989: 458-460). By treating the pre-tests scores as covariates, results from an ANCOVA can answer the question "had the two groups started with the same score at the pre-test would they then be different at post-test?" For this report, ANCOVA was performed in each of the dependent variables' post-test scores. The pre-test scores were used as covariates. The p- value for the study was 0.05.

6.3 ANCOVA Assumptions

The ANCOVA General Linear Model Procedure was applied to the post-test scores, having the pre-test scores as covariates to each of the dependent variables: accuracy, answer, latency, efficiency, and ICT-awareness. This type of methodology provides convincing results in educational research (Todman & Dugrad, 1995) when certain conditions have been met (Mok & Wheldall, 1995). In addition to the ANCOVA results and descriptive statistics, effect size measurements for each dependent variable were included in accordance with APA publications manual 5th edition 2005 (Robey, 2004). Before proceeding with the use of ANCOVA certain assumptions have to be met. Among the multiple conditions, the following five conditions must not be violated if the interpretation of results is to be correct:

- Random allocation between subjects into the treatment conditions (Mok & Wheldall, 1995)
- No covariate outliers (Garson, 2004)

- Homogeneity of variance:

  a) Approximately normal distribution of the covariate

  b) Groups of similar size (Todman & Dugard, 1995)

- Linear relationship between the covariate and the dependent variable (Keppel and Zedeck, 1989).

- The homogeneity of regression assumption (Mok & Wheldall, 1995)

Random allocation between subjects in the treatment condition was achieved in the thesis experiment. As indicated earlier, the users exposed to the software (treatment condition) were randomly selected using a coin-toss method. Thus, this condition was met for all the dependent variables (accuracy, answer, latency, efficiency, and ICT-awareness).

Condition two, no covariate outliers, refers to unusual values. Outliers are those values of four or more standard deviations from the mean (Hunt et al, 2000). Box plots of the data for accuracy and answer, latency, and efficiency dependent variables reveal that there were no outliers for any of the covariates (Figures 36, 37 & 38).

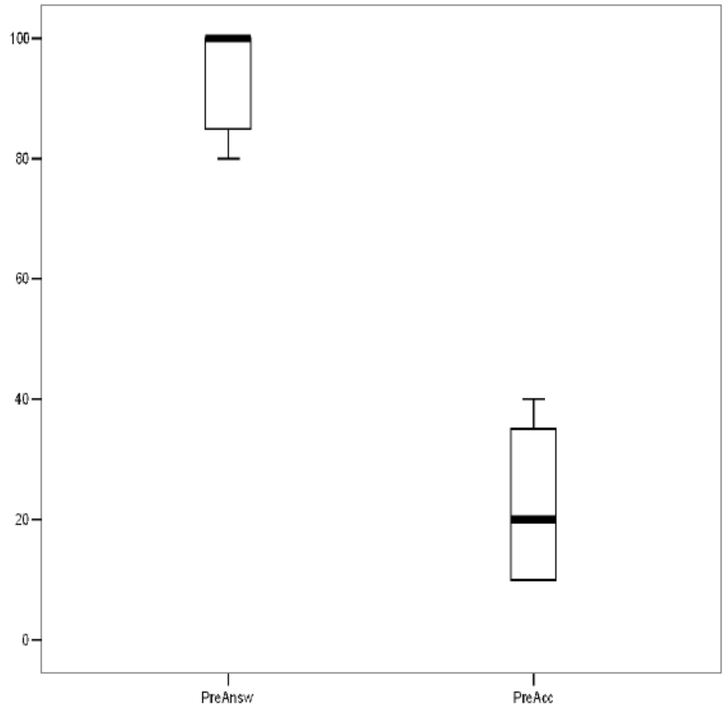


Figure 36. Box Plot for accuracy and answer

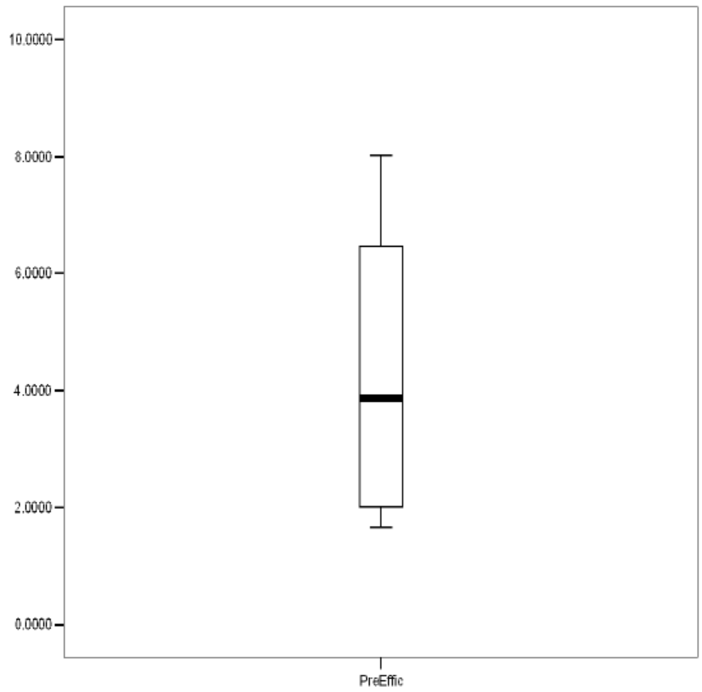


Figure 37. Box plot for efficiency

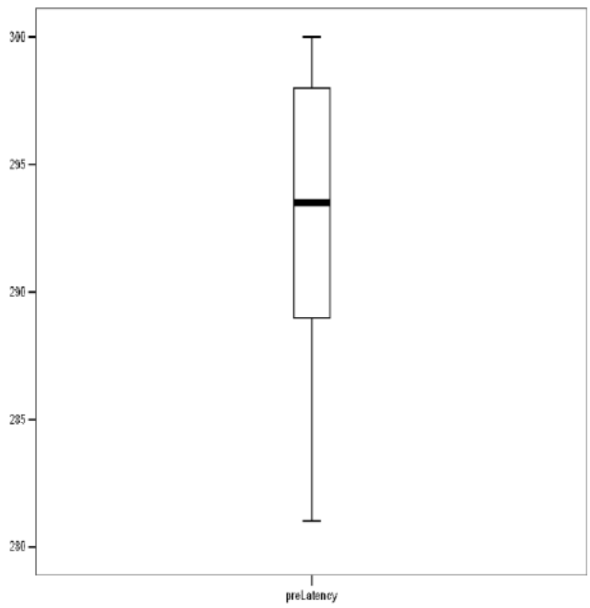


Figure 38. Box plot for latency

In relation to condition three, homogeneity of variance, Todman and Dugard (1995) indicate that having a normal distribution of the covariates and similar group sizes makes ANCOVA impervious to any possible departure from the homogeneity of variance assumption. All the variables regarding mathematical instruction met the Skewness and Kurtosis condition for normal distributions (Table 14). Each group had 20 members which meets the group size condition. Skewness and kurtosis provide a means to test normality. It is recommended to run descriptive statistics and obtain skewness and kurtosis, and then divide the results by the corresponding standard error. Skew values must be between the 2 to -2 range, with kurtosis in the range of 3 to -3, if the curve is to be normally distributed.

Table 14. Skewness and kurtosis conditions

	Statistic skwedness	Std. Error skewedness	Skwedness /Std error	Statistic kurtosis	Std. Error kurtosis	Kurtos i/Std error
PreEffic	.630	.374	1.7	-1.087	.733	-1.5
PreAnswer	-.636	.374	-1.7	-1.333	.733	-1.8
Pre-Lat	-.414	.374	-1.11	-.923	.733	-1.26
Pre-accuracy	.592	.374	1.6	-1.191	.733	-1.63

Condition four, which refers to the linear relationship between the covariate and the dependent variable, was calculated using SPSS statistical software for all the dependent variables. Keppel and Zedeck (1989) indicate that ANCOVA is recommended when the Pearson Correlation Coefficient, *r*, is greater than 0.6. Other authors, such as Todman and Dugard (1995), indicate that having a positive linear relationship between the covariate and the dependent variable is sufficient to proceed with ANCOVA. In the case of accuracy, the Pearson Correlation Coefficient had a positive value equal to $r = .659$ (Table 15). The positive correlation coefficient was statistically significant ($p < .05$), indicating that those who had done better in the pre-test had also done better in the post-test concerning accuracy. A linear relationship was observed empirically by plotting accuracy post-test scores with the pre-test scores.

Table 15. Pearson correlation coefficient for accuracy

		Post-acc	Pre-acc
Post-acc	Pearson Correlation	1	.659(**)
	Sig. (2-tailed)		.000
	N	40	40
Pre-acc	Pearson Correlation	.659(**)	1
	Sig. (2-tailed)	.000	
	N	40	40

** Correlation is significant at the 0.01 level (2-tailed).

Condition five, the homogeneity assumption, also known as the homogeneity of covariate regression coefficients, indicates that the covariate coefficients (sloping regression lines) for all the groups in the analysis are equal. Any interaction effect between the covariates (pre-test) and the factors (group) indicates a breach of the assumption (Garson, 2004). The assumption was tested by examining the group covariate-factor interactions as well as by covariate-covariate interactions for the accuracy variable (Table 16).

Table 16. Assumption of homogeneity for accuracy

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	10468.752(a)	3	3489.584	3.945	.000
Intercept	1700.600	1	1700.600	6.289	.000
Group	663.691	1	663.691	0.260	.003
Pre-acc	5119.216	1	5119.216	9.138	.000
Group * Pre-acc	68.669		68.669	1.062	.310
Error	2328.748	36	64.687		
Total	61100.000	40			
Corrected Total	12797.500	39			

(a) R Squared = .818 (Adjusted R Squared = .803)

In the case of the thesis experiment there was only one covariate-factor interaction (Group*Pre-acc). As can be noted in Table 16, the Group*Pre-acc effect had a low F statistic (F=1.062) and a non-statistical significance level p= .310. Therefore the assumption of homogeneity was met and ANCOVA was acceptable.

In the case of answer, the Pearson Correlation Coefficient had a positive value equal to r = .817. This value is acceptable to perform ANCOVA analysis (Table 17). Just as in accuracy, the positive correlation coefficient for answer was statistically significant (p < .05), indicating that those who had done better in the pre-test had also done better in the post-test. A linear relationship was observed empirically by plotting the answer post-test scores with the pre-test scores. The same methodology used for accuracy was applied to test the homogeneity regression assumption (Table 18).

Table 17. Pearson correlation coefficient for answer

		Post-answer	Pre-answer
Post-answer	Pearson Correlation	1	.817(**)
	Sig. (2-tailed)		.000
	N	40	40
Pre-answer	Pearson Correlation	.817(**)	1
	Sig. (2-tailed)	.000	
	N	40	40

** Correlation is significant at the 0.01 level (2-tailed).

Similar to the results for accuracy, there was only one covariate-factor interaction (Group*Pre-answer) for homogeneity. As can be noted in Table 18, the Group*Pre-answer effect had a low F statistic (F=3.300) and a non-significant level p= .078. Therefore the assumption of homogeneity was met and ANCOVA was acceptable.

Table 18. Assumption of homogeneity for answer

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	648.906	3	216.302	34.064	.000
Intercept	1008.429	1	1008.429	158.812	.000
Group	26.420	1	26.420	4.161	.049
Pre-answer	534.029	1	534.029	84.101	.000
Group *Pre-answer	20.955	1	20.955	3.300	.078
Error	228.594	36	6.350		
Total	375300.000	40			
Corrected Total	877.500	39			

In the case of latency, the Pearson Correlation Coefficient had a positive value equal to $r = .370$. This value is still acceptable to perform ANCOVA analysis (Table 19). Similar to the results for answer and accuracy, the correlation coefficient for latency was statistically significant ($p < .05$), indicating that those who had done better in the pre-test had also done better in the post-test. A linear relationship was observed empirically by plotting the latency post-test scores with the pre-test scores.

Table 19. Pearson correlation coefficient for latency

		Post-latency	Pre-latency
Post-latency	Pearson Correlation	1	.370(*)
	Sig. (2-tailed)		.019
	N	40	40
Pre-latency	Pearson Correlation	.370(*)	1
	Sig. (2-tailed)	.019	
	N	40	40

* Correlation is significant at the 0.05 level (2-tailed).

The same methodology regarding latency used for the variables answer and accuracy was applied to test the homogeneity regression assumption (Table 20). Similar to the results for answer and accuracy, there was only one covariate-factor interaction for homogeneity (Group*pre-latency). The Group*pre-latency effect had a low F statistic (F=1.255) and a non-statistical significance level p= .270. Therefore the assumption of homogeneity had been met and ANCOVA was acceptable.

Table 20. Assumption of homogeneity for latency

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	8476.614(a)	3	2825.538	15683.559	.000
Intercept	5.455	1	5.455	30.280	.000
Group	1.226	1	1.226	6.806	.013
Pre-latency	1205.092	1	1205.092	6689.037	.000
Group * pre-latency	.226	1	.226	1.255	.270
Error	6.486	36	.180		
Total	3069892.000	40			
Corrected Total	8483.100	39			

R Squared = .999 (Adjusted R Squared = .999)

For the variable efficiency, the Pearson Correlation Coefficient had a positive value of $r = .614$. This positive correlation coefficient was statistically significant ($p < .05$), indicating the same conclusion as reached in the previous variables; better post-test results were obtained by those users who had better pre-test results (Table 21).

Table 21. Pearson correlation coefficient for efficiency

		Post-effic	Pre-effic
Post-effic	Pearson Correlation	1	.614(**)
	Sig. (2-tailed)		.000
	N	40	40
Pre-effic	Pearson Correlation	.614(**)	1
	Sig. (2-tailed)	.000	
	N	40	40

** Correlation is significant at the 0.01 level (2-tailed).

The homogeneity of the regression assumption for efficiency met the same criteria as the previous variables. The Group*Pre-effic effect had a low *F* statistic (F=2.817) and a non-statistical significance level p= .102. Therefore the assumption of homogeneity was met and ANCOVA was acceptable (Table 22).

Table 22. Assumption of homogeneity for efficiency

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	578.258(a)	3	192.753	58.946	.000
Intercept	87.963	1	87.963	26.900	.000
Group	33.472	1	33.472	10.236	.003
Pre-effic	224.226	1	224.226	68.571	.000
Group * Pre-effic	9.210	1	9.210	2.817	.102
Error	117.719	36	3.270		
Total	2893.605	40			
Corrected Total	695.977	39			

R Squared = .831 (Adjusted R Squared = .817)

ICT-awareness met all the ANCOVA conditions. As in the previous variables, random allocation between the subjects into the treatment categories came from the groups' distribution by a coin-toss method. A box plot of the ICT-awareness variable (Figure 39) showed no covariate outliers.

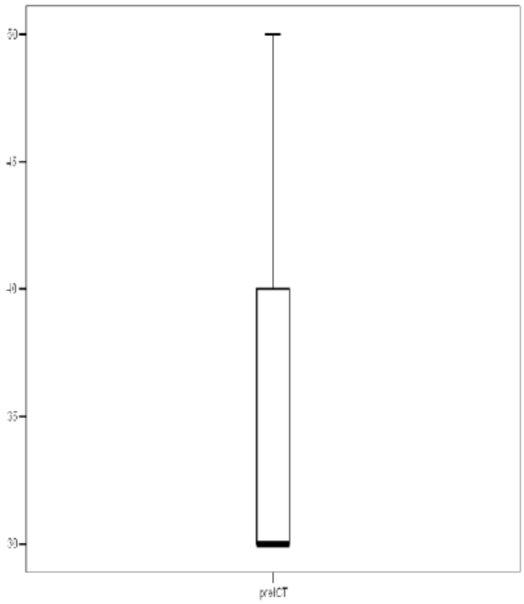


Figure 39. Box plot for ICT-awareness

Skewness and kurtosis ratios to their corresponding standard deviation values fell within the -3 to 3 range, which indicated a normal distribution (Table 23).

Table 23. Skewness and kurtosis conditions

	Statistic skwedness	Std. Error skewednes s	Skwedness /Std error	Statistic kurtosis	Std. Error kurtosis	Kurtos i/Std error
Pre-ICT	.963	.374	2.6	.006	.733	.008

The ICT-awareness Pearson Correlation Coefficient had a positive value of $r = .349$. This is an acceptable value to determine a linear relationship between the post-test and the pre-test results (Table 24).

Table 24. Pearson correlation coefficient for ICT-awareness

		Post-ICT	Pre-ICT
Post-ICT	Pearson Correlation	1	.349(*)
	Sig. (2-tailed)		.027
	N	40	40
Pre-ICT	Pearson Correlation	.349(*)	1
	Sig. (2-tailed)	.027	
	N	40	40

* Correlation is significant at the 0.05 level (2-tailed).

Similar to the mathematical instruction variables, the Group*Pre-ICT effect had a low *F* statistic (*F*=.693) and a non-significant level *p*= .411. Therefore the assumption of homogeneity was met and ANCOVA was acceptable (Table 25).

Table 25. Assumption of homogeneity for ICT-awareness

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	17686.071(a)	3	5895.357	2321.297	.000
Intercept	496.901	1	496.901	195.655	.000
Group	496.901	1	496.901	195.655	.000
Pre-ICT	1282.919	1	1282.919	505.149	.000
Group * pre-ICT	1.760	1	1.760	.693	.411
Error	91.429	36	2.540		
Total	135500.000	40			
Corrected Total	17777.500	39			

R Squared = .995 (Adjusted R Squared = .994)

6.4 Effect Size

The APA publication manual, fifth edition, recommends that papers submitted include measurements of effect size (Robey, 2004). Effect size can be measured either by comparing the two means, or as an effect size correlation (Becker (2001). Becker (2001) indicates that in relation to correlated designs, as in the case of the thesis experiment, it is best to use the original standard deviations of the treatment and experimental groups. This means obtaining the differences between each group, preferably from the post-tests scores. The reason for this is that it is less probable that measures taken at the same time will have any historical influence (Becker, 2001). There are various measurements that can be used to obtain effect size, but the most common in meta-analysis is Cohen´s *d* (Becker, 2001). The value of *d* is obtained with the formula:

$$d = M1 - M2 / \sigma pooled$$

where,

M1 = post-test experimental group mean scores

M2 = post-test control group mean scores

and

σpooled = pooled standard deviation obtained with the formula $\sqrt{[\sigma 1^2 + \sigma 2^2 /2]}$

where $\sigma 1$= post-test experimental group standard deviation AND $\sigma 2$ = post-test control group standard deviation.

6.4.i ANCOVA for Accuracy

ANCOVA was run in SPSS using GLM, taking accuracy (post-acc) as the dependent variable, pre-test accuracy scores (pre-acc) as covariate, and group (control and treatment) as a fixed factor. Results (Table 26) showed that the covariate (pre-test scores) had a significant linear relationship with the dependent variable post-acc, as can be seen from the F statistic (F=82.376) and its corresponding significance value (p<.05). The aforementioned linear relationship indicated that the values of the post-test accuracy scores increased as the values of the pre-test accuracy scores increased.

The other source of variance group also had a significant F statistic (F=74.737) and a significance level of p=.000. This indicated that the variance that can be uniquely attributed to group membership (control or treatment) was statistically significant. That is to say that there was a statistically significant difference between the post-test accuracy scores of the experimental and those of the control group (Table 26).

Table 26. ANCOVA results for accuracy (post-acc)

Source	Type III 263umo f Squares	Df	Mean Square	F	Sig.
Corrected Model	10400.083(a)	2	5200.041	80.254	.000
Intercept	1651.200	1	1651.200	25.483	.000
Pre-acc	5337.583	1	5337.583	82.376	.000
Group	4842.565	1	4842.565	74.737	.000
Error	2397.417	37	64.795		
Total	61100.000	40			
Corrected Total	12797.500	39			

R Squared = .813 (Adjusted R Squared = .803)

6.4.ii Effect Size for Accuracy

Calculating effect size for accuracy resulted in $d = 1.57$. According to Cohen (in Becker, 2001), a value of 1.57 indicates a large size effect. According to the same source, a d value of 1.6 indicated that the mean of the experimental group was at the 94.5th percentile of the control group mean.

6.4.iii ANCOVA for Answer

The process for analysing answer was identical to that of accuracy. ANCOVA was run in SPSS using GLM with answer (post-answer) as a dependent variable, pre-test answer scores (pre-answer) as the covariate and the group (control and treatment) as a fixed factor. Reviewing the output (Table 27), the covariate (pre-test score) had a significant linear relationship with the dependent variable post-answer, F statistic

(F=83.838) and its corresponding significance value (p<.05). As in the case of accuracy, the linear relationship indicated that the values of the post-test answer scores increased as the values of the pre-test answer scores increased.

The source of variance group was not as big as in the previous variable, however it had still a significant F statistic (F=6.227). Although this was a smaller significance level than its previous counterpart, it was still statistically significant p=.017. The same conclusion reached for accuracy was reached for answer: the variance uniquely attributed to group membership (control or treatment) was statistically significant. That is to say that a statistically significant difference existed between post-test answer scores from the experimental group and those of the control group (Table 27).

Table 27. ANCOVA results for answer (post-answer.)

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	627.951(a)	2	313.975	46.552	.000
Intercept	988.178	1	988.178	146.54	.000
Pre-answer	565.451	1	565.451	83.838	.000
Group	42.000	1	42.000	6.227	.017
Error	249.549	37	6.745		
Total	375300.000	40			
Corrected Total	877.500	39			

R Squared = .716 (Adjusted R Squared = .700)

6.4.iv Effect Size for Answer

Using formula for d to compute effect sizes for answer resulted in d = 0,54

$$d = 98.00\text{-}95.50 / [\sqrt{(4.104^2 + 5.104^2 / 2)}] = 0.54$$

Again, referring to Cohen (in Becker, 2001), a value of 0.54 indicates a medium size effect. This value indicated that the mean of the experimental group was at the 33rd percentile of the control group mean (Becker, 2001).

6.4.v ANCOVA for Latency

The process for analysing latency was identical to that of the two previous dependent variables. ANCOVA was run in SPSS using GLM with latency (post-latency) as a dependent variable, pre-test latency scores (pre-latency) as covariate, and group (control and treatment) as a fixed factor. Reading SPSS output (Table 28), the covariate (pre-test scores) had a significant linear relationship with the dependent variable post-test latency scores (post-latency), as concluded from its F statistic (F=6837.309) and its corresponding significance value (p<.05). Just as for accuracy and answer, the linear relationship indicated that the values of the post-test latency scores increased as the values of the pre-test latency scores increased.

Analysing the source of variance group, there was a greater significant F statistic (F=40335.227) as in the previous variables. The significance level was p=.000. Therefore the same conclusion for accuracy and answer was reached for latency: the variance uniquely attributed to group membership (control or treatment) was statistically significant, and there was a statistically significant difference between latency post-test scores from the experimental group as compared to those of the control group (Table 28).

Table 28. ANCOVA results for latency (post-latency)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	8476.388(a)	2	4238.194	23363.797	.000
Intercept	5.952	1	5.952	32.809	.000
Pre-latency	1240.288	1	1240.288	6837.309	.000
Group	7316.801	1	7316.801	40335.162	.000
Error	6.712	37	.181		
Total	3069892.000	40			
Corrected Total	8483.100	39			

R Squared = .999 (Adjusted R Squared = .999)

ANCOVA analysis of the dependent variables accuracy, answer, and latency produced very similar results. However, the result of effect size for latency was different.

6.4.vi Effect Size for Latency

In the case of the dependent variable, latency:

$$d = 263.2\text{-}290.10 / [\sqrt{(6.223^2 + 5.187^2 / 2)}] = -4..70$$

According to Cohen (Becker, 2001), *d*= -4.70 indicates a large size effect in a decreasing direction. A *d* = -4.70 indicated that the mean of the experimental group was at the 99th percentile of the control group mean.

6.4.vii ANCOVA for Efficiency

ANCOVA for efficiency was run in SPSS using GLM with efficiency (post-effic) as a dependent variable, pre-test efficiency scores (pre-effic) as covariate, and group (control and treatment) as a fixed factor. Output from SPSS (Table 29) indicated that the covariate (pre-test scores) had a significant linear relationship with the dependent variable post-effic, as can be seen from its F statistic (F=70.143) and its corresponding significance value p=.000. As in the case of the previous dependent variables, the values of the post-test efficiency scores increased as the values of pre-test efficiency scores increased.

Group also had a significant F statistic (F=89.368) and was statistically significant (p<.05). This result indicated that the variance that could be uniquely attributed to group membership (control or treatment) was statistically significant. Once again, here was a statistically significant difference between efficiency post-test scores from the experimental group as compared to those of the control group (Table 29).

Table 29. ANCOVA results for efficiency

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	569.048(a)	2	284.524	82.939	.000
Intercept	83.294	1	83.294	24.280	.000
Pre-effic	240.627	1	240.627	70.143	.000
Group	306.579	1	306.579	89.368	.000
Error	126.929	37	3.431		
Total	2893.605	40			
Corrected Total	695.977	39			

R Squared = .817 (Adjusted R Squared = .807)

6.4.viii Effect Size for Efficiency

In the case of the dependent variable, efficiency:

$$d = 10.277600\text{-}4.546800 / [\sqrt{(3.8542644^2 + 2.1188898^2/2)}] = 1.9$$

According to Cohen (Becker, 2001), a value of 1.9 indicates a large size effect. Or, as found in the same source, a *d* value of 1.9 indicated that the mean of the experimental group was at the 97.1 percentile of the control group mean.

6.4.ix Descriptive Statistics for ICT-Awareness

Users in the experimental group exhibited a 39.5 point difference between their ICT-awareness post-test mean scores (*M*= 74.50, *SD*= 6.048) and their pre-test mean scores (*M*= 35, *SD*= 6.070). The control group exhibited no relevant variation in the post-test (*M*= 34, *SD*= 5.982) and pre-test (*M*= 34, *SD*= 5.982) comparison (Table 30).

Table 30. Means and standard deviation for ICT-awareness

Group		Pre-ICT	Post-ICT
Control	N	20	20
	Mean	34	34
	Std. Deviation	5.982	5.982
Experimental	N	20	20
	Mean	35	74.50
	Std. Deviation	6.070	6.048

The value of the ICT-awareness post-test treatment group mean exhibited a large increase. Meanwhile, the control group mean in the pre-test and post-test remained almost identical (Figure 40).

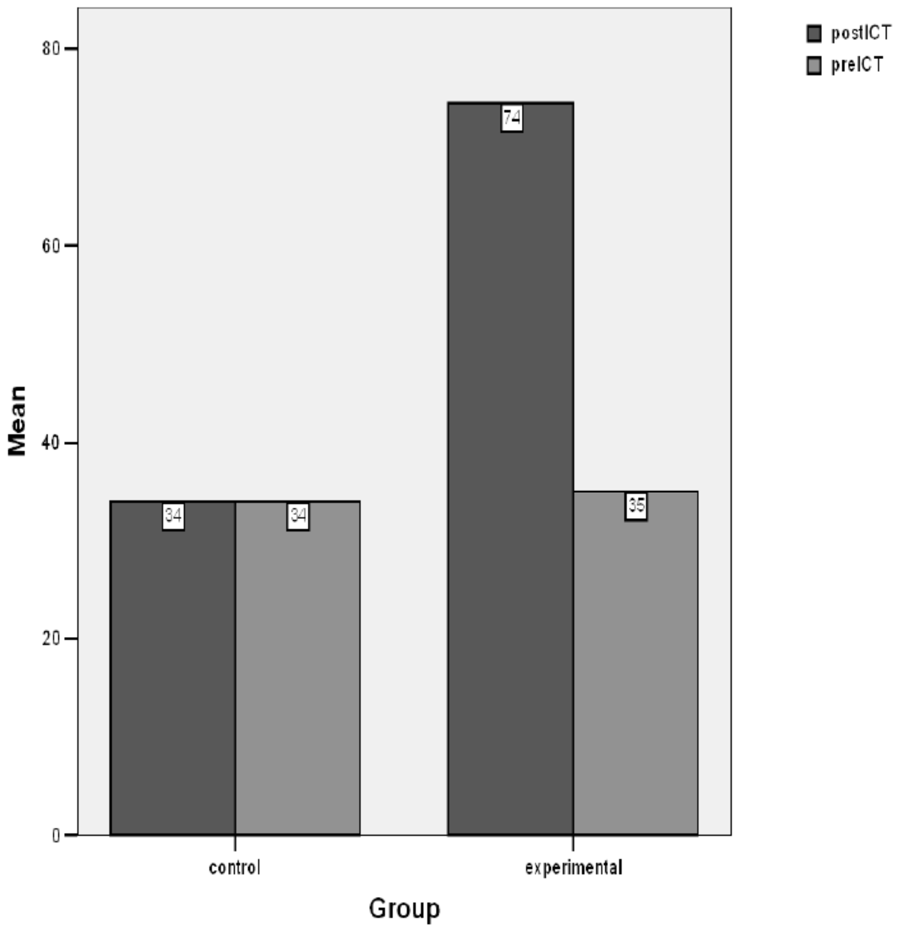


Figure 40. ICT-Awareness means

6.4.x Analysis of Covariance for ICT-Awareness

The covariate (pre-test scores) for ICT had a significant linear relationship with the dependent variable post-ICT-awareness F statistic (F=508.937) and its corresponding significance value p=.000. As in the previous variables, this relationship indicated that the values of the post-test ICT-awareness scores increased as the values of the pre-test ICT-awareness scores increased. The group also had a significant F statistic (F=6161.617) and a significance level that was statistically significant p=.000. This meant there was a statistically significant difference between the ICT-awareness post-test scores of the experimental group and those of the control group (Table 31).

Table 31. ANCOVA Results for ICT-Awareness

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	17684.312(a)	2	8842.156	3510.735	.000
Intercept	496.901	1	496.901	197.292	.000
Pre-ICT	1281.812	1	1281.812	508.937	.000
Group	15518.682	1	15518.682	6161.617	.000
Error	93.188	37	2.519		
Total	135500.000	40			
Corrected Total	17777.500	39			

R Squared = .995 (Adjusted R Squared = .994)

6.4.xi Effect Size for ICT-Awareness

$$d = 74.50\text{-}34 / [\sqrt{(6.048^2 + 6.070^2/2)}] = 6.7$$

A value of 6.7 signified a large size effect, which indicated that the mean of the experimental group was at the 99 percentile of the control group mean.

CHAPTER VII: DISCUSSION

7.1 RESEARCH QUESTIONS

This thesis posed two major research questions:

- Is e-Ludic learning an effective alternative educational tool for low ITC-aware populations?
- Does e-Ludic learning effectively increase ICT awareness in low ICT-aware populations?

The answer to question one was based on the test condition I set up in which the results of the mathematical instruction variables accuracy, answer, latency, and efficiency were limited to the domain of basic mathematical instruction and automaticity learning theory. To answer question two I used the same test conditions referred to above and the corresponding results for the ICT-aware variable.

7.1.i Accuracy

As the experiment results indicate, accuracy values showed a group membership effect that was statistically significant. Accuracy effect sizes were also representative, meaning that the experimental group, those students who were exposed to the e-Ludic environment, increased their accuracy in single-digit addition operations compared to those of the control group, those students not exposed to the e-Ludic environment.

Increases in accuracy measurements have been found in similar experiments (Tournaky, 2003 and Caloa & Din, 2001), indicating that the use of e-Ludic learning technology can enhance the number of correct answers in a given arithmetic examination. A higher accuracy score shows that the student knows the answer, indicating that the learning process has occurred in the student's mind.

7.1.ii Answer

ANCOVA, effect sizes, and descriptive statistics for answer all indicate that a cause and effect relationship is occurring in the e-Ludic learning process. The students in the experimental group answered more questions than those in the control group. This variable provides an indication of knowledge acquisition related to familiarity with the content. Students became more familiar with the symbols involved in addition operations, which is why they answered more questions, whether right or wrong. The results indicate that those students exposed to the software gained greater familiarity with the content and were thus able to answer more questions.

7.1.iii Latency

Latency results exhibited the same tendency as in the previous two variables; a statistically significant gain for the experimental group. As previously explained, latency represents the speed at which students answered as many questions as possible. The effect relationship indicates that those in the experimental group increased their speed compared to those in the control group. Students answered as many questions as posible, and when they did not know the answer to a question they were instructed to continue to the next ítem, having a maximum of 10 minutes to finish the test. Every student finished the test within the 10 minute limit.

7.1.iv Efficiency

I constructed efficiency out of the three previous variables: ANCOVA, effect sizes, and descriptive statistics. Once again, the results show a statistically significant group membership effect. Students in the experimental group attained much higher values compared to those in the control group. The e-Ludic process augmented the students' efficiency in answering the post-test questions.

Efficiency values indicate knowledge acquisition in standardised measurements. It is not implied that the learning process is permanent, rather that it is more efficient. In this regard, the first research question has been answered positively. The answer to research question two comes from results obtained for the ICT-awareness variable.

ANCOVA, effect sizes, and descriptive statistics applied to the ICT-awareness variable indicated a statistically significant relationship for group membership. Students in the experiment group increased their knowledge of ICT concepts after being exposed to the e-Ludic learning process.

7.2 THESIS LIMITATIONS

The thesis research has three limitations: content domain, sample population, and technology.

7.2.i Content Domain

I created the content for LHADP based on the urgent need in Mexico for higher numeric skills in basic education. Nonetheless, e-Ludic learning should be equally effective in other fields of knowledge such as literacy and the social sciences. While research on e-Ludic learning in relation to other disciplines is not abundant, there are currently numerous initiatives to develop e-Ludic learning environments with different content domains. One example is the Learning Federation, an initiative of the Australian government to provide e-Ludic learning content to schools. Later in this chapter I outline the Learning Federation's learning objects and describe how they are delivered through a learning management system.

7.2.ii Sample Population

The sample population for this research was Year One students in a low ICT-aware school in the state of Puebla, Mexico. E-Ludic learning should be effective for any age group and population type. Further research is required in this area, with the use of adequate statistical tools such as ANCOVA to measure its effectiveness.

7.2.iii Technology

The use of a dial-up Internet connection considerably limits the applicability and development of e-Ludic learning solutions. For the thesis experiment, I had to remove certain ludic elements from the environment interface due to speed connection considerations. The limitations of this thesis can be overcome in future experiments through the use of broadband Internet access to deliver a greater number of ludic and interactive interfaces. Notwithstanding, e-Ludic applications are increasingly being used in all levels of education and training (Prensky, 2007). Tech-savvy Generation X and Y members are very comfortable learning with ludic applications wherein technology is a major component (Barkey, personal communication, October 5, 2005). The increasing use e-Ludic learning makes any research findings in the matter even more important. This research has contributed to the e-learning literature in two areas as explained below.

7.3 IMPLICATIONS FOR RESEARCH

The thesis findings have implications for research in e-learning development and low-ICT aware regional development. Both areas have recently gained much-needed attention in academia as well as in the policy arena. E-learning has been criticised as being too boring and suffering from too slow a penetration among users (McCue, 2007). Current practices have focused on organising content online through learning management systems (LMS) such as *Moodle* and *Blackboard Learning System* for the educational sector, and *Saba Learning Suite* and *SumTotal* systems for the corporate sector. However, this practice has not modified the perception among many online users that the content remains unengaging (USC survey, 2009). The findings of the thesis experiment, that e-Ludic learning provides an efficient and alternative learning tool to deliver engaging content through e-learning channels, have considerable implications for e-learning dissemination.

Some researchers have been cautious in embracing the use of ludic environments as learning tools. However, the perception regarding ludic worlds as educational tools has been changing in recent years with the emergence of more research on the subject (Gee, 2007). Younger generations of learners tend to feel more comfortable with playful and engaging online elements than their older counterparts (Prensky, 2007). E-Ludic learning meets the gaming needs of younger learners and their request for more engaging interfaces. These new generations of learners require the type of structured online content provided through LMS. Learning management systems that incorporate e-Ludic learning content in the form of learning objects in a pedagogical model (Siemmens, 2004), become learning content management systems (LCMS). LCMSs are based on learning object models to deliver content and engagement.

There are multiple definitions for learning objects, but the general consensus is that a learning object must use a variety of media resources like video, graphics, multimedia, and audio. It must be engaging and interactive, and must have a clear learning and pedagogical objective (Haughey & Muirhead, 2005). Learning objects are contained within an LCMS and are transferable using a sharable content object reference model (SCORM). SCORM-compliant learning objects are re-usable through LCMSs that accept SCORM-based objects.

Currently, institutions that have implemented LCMSs as part of their e-learning strategy have realised that learners want more interactive and engaging content

(Asirvatham, 2005; Means et al., 2009). E-Ludic learning provides a framework for designing engaging and interactive learning objects such as those of the Australian Learning Federation project (TLF). The Learning Federation (established in 2006) is a joint initiative of the Australian commonwealth government and the New Zealand government to deliver online curriculum to K-12 institutions in both countries. The material created or licensed by TLF can be accessed by any Australian or New Zealand school that signs up and adheres to the licensing and usage policies specified in the user agreement. The Learning Federation's learning objects can be accessed through the *basic e-learning distribution tool set* (BELTS), which is an LCMS (Figure 41).

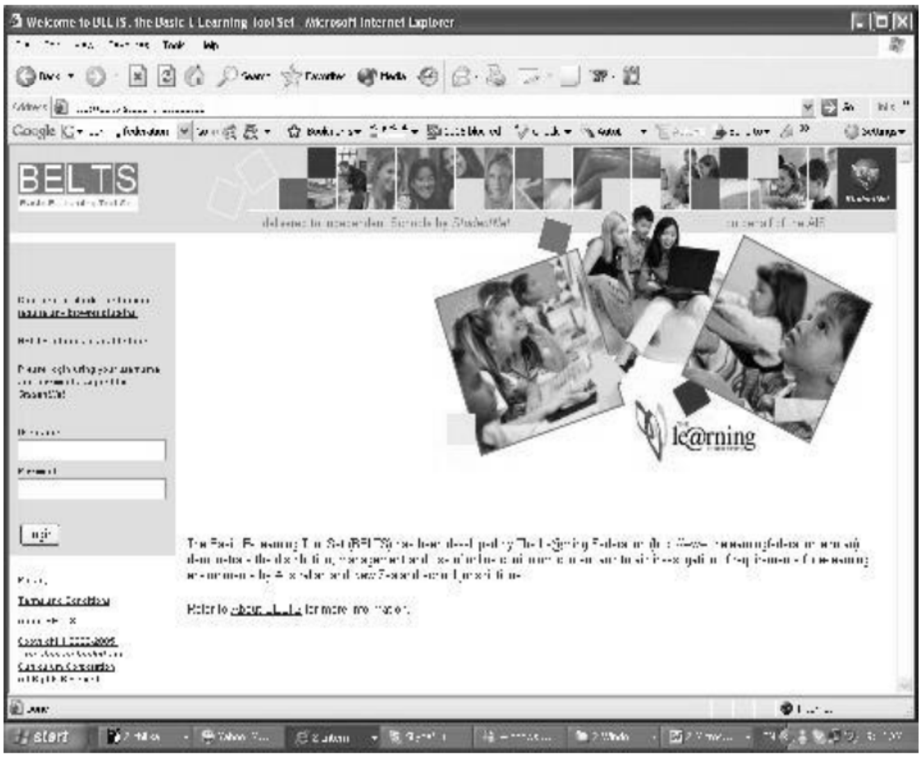


Figure 41. The learning federation website (The Learning Federation)

BELTS was designed by the TLF team as a LCMS tool. It is a basic management tool that enables simple *database storage* and *retrieval*. TLF does not require the use of BELTS to access its content; its content can be integrated into any learning content management tool as long as the copyright and licensing requirements are fulfilled. I personally integrated TLF content into an in-house LCMS I partially developed. TLF content is grouped into seven categories:

- Science
- Mathematics and numeracy
- Literacy for students at risk
- Studies of Australia and New Zealand
- Languages other than English: Chinese, Japanese, and Indonesian
- Arts, design, and technology
- Business and Enterprise

Each category contains approximately 80 learning objects or online software resources. Every learning object requires Macromedia Shockwave or Flash player in order to be accessed by the user. The learning objects can be downloaded into the school server and accessed through the system intranet or via the Internet using BELTS or, as in our case, the in-house LCMS. I reviewed most of the learning objects, and then selected 12 titles per category based on the content and learning outcomes suggested, with one per academic year for science, mathematics, and literacy.

For science I selected:

- Year One: Animal groups: At the zoo 1 – students are presented with multiple animals. Varied creatures are characterised as either vertebrates or invertebrates.
- Year Two: the Desert – students learn about different food sources in the desert.
- Year Three: Old Bernie's story.
- Year Four: Energy from the Sun – this learning object teaches students the multiple applications that the sun’s energy has (Figure 42).

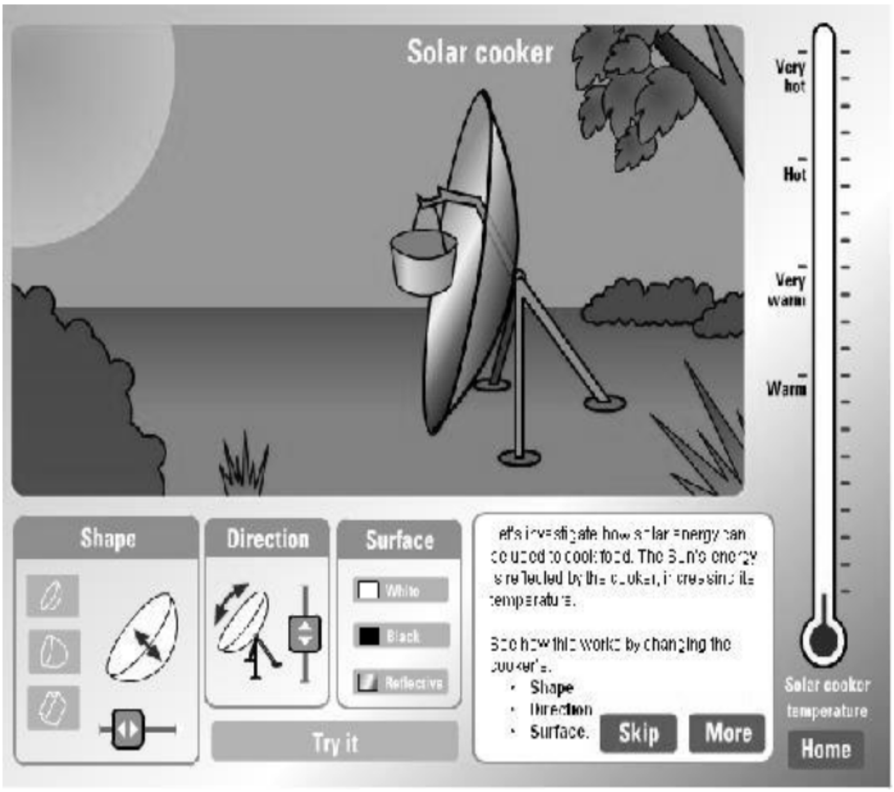


Figure 42. Energy from the sun interface (The Learning Federation)

- Year Five: Blood – students gain knowledge of the elements that constitute human blood.
- Year Six: Digestive system.
- Year Seven: Exploring Earth's structure; Earth probe – students learn some of the Earth's core properties like temperature, pressure and layers.
- Year Eight: Making water drinkable; Water and us – this learning object showcases the importance of water. It teaches students about water cycles and properties like dissolving other substances.
- Year Nine: Isotopes and Radiation – students are introduced to radiation and isotopes. They learn about different mechanisms and processes of smoke detection, radiation testing and absorption of materials.
- Year Ten: Science Reporter; Electronics Engineer – role playing environment where students pretend to be reporters and research the qualifications of an electronics engineer. They elaborate a newspaper article using digital images showing their expertise.
- Year 11: Forensic science; DNA.
- Year 12: The Secret of Itsall Mine – students apply geological concepts and use geological accessories to look for a missing fossil. They put together samples of rocks and solve Earth related puzzles to find the fossil.

For mathematics I selected:

- Year One: Monster Choir; making patterns – children learn about sequencing using sounds and repeating patterns.
- Year Two: Area Counting with Coco.
- Year Three: Design a Park – children learn how to outline and design a plan for a park helping the character “Terry the town planner”. They also learn about mathematical fractions through boxes and a line of numbers (Figure 43).

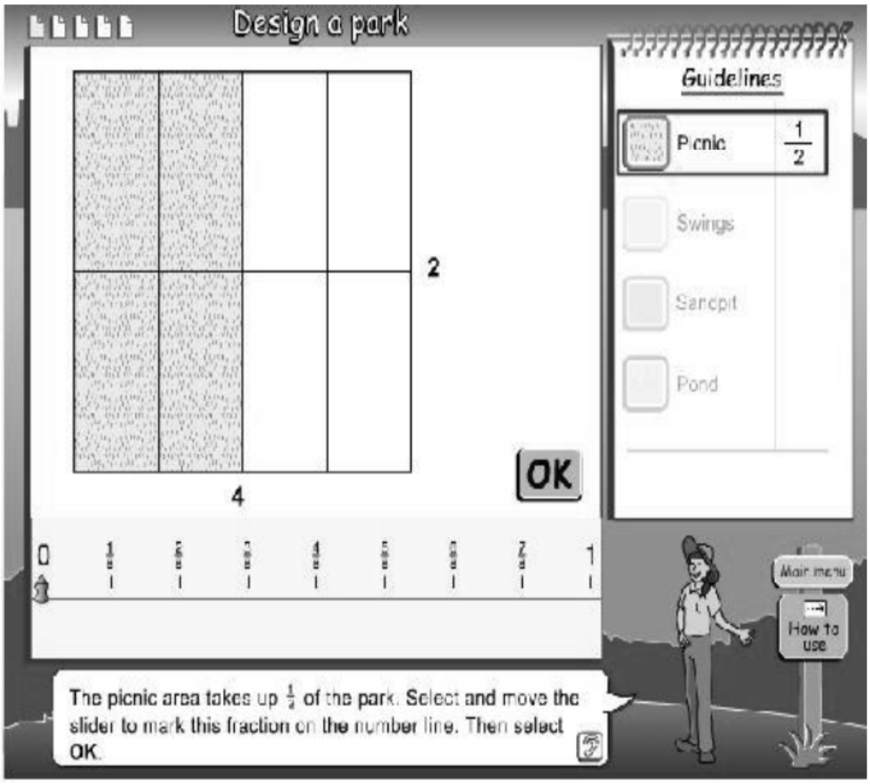


Figure 43. Design a park interface (The Learning Federation)

- Year Four: Building Site – children create an avenue view with dimensional perspective. This learning object has four progressing levels of difficulty..
- Year Five: Bridge Builder; complex pentagons – students gain knowledge and understanding of bridges. This is the last learning object in a set of five that become progressively more difficult to play.
- Year Six: Algebra Balance Scales – students learn about linear equations and how to solve them.
- Year Seven: Design a Neighbourhood.
- Year Eight: Geoboard – students interact with a geoboard to discover properties of varied geometrical figures.
- Year Nine: Box plot/Histogram.
- Year Ten: Sea Rescue – students have to save a dog from a drifting boat before it capsizes. They control course and speed of the boat and learn playing with variables like speed, distance and time and measurements like angles and vectors (Figure 44).

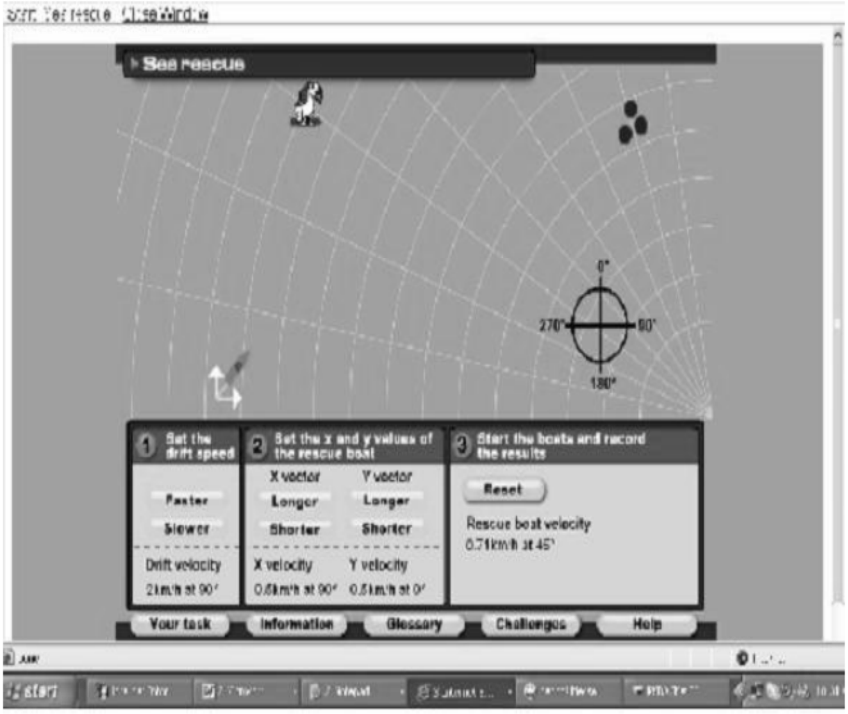


Figure 44. Sea rescue interface (The Learning Federation)

- Year Eleven: Maths and the Car; Loan calculator.
- Year Twelve: Graphing; Line of best fit.

The above titles cover Year One to Year Twelve content regarding mathematics and literacy, within an e-Ludic learning format. I had 80 students access the content through my in-house LCMS. The majority of the students indicated that they had fun, and believed that they were learning. Some research has been carried out regarding the use and impact of TLF content. Reiman et al. (2009) found that TLF content is perceived as useful by teachers and beneficial by students. In the case of my users, empirical conclusions based on the childrens' perceptions suggested that a process of knowledge acquisition took place during the playing time.

Institutions in Australia are currently integrating *Moodle*, an open source LCMS with TLF content, with *Scootle* (Reiman et al., 2009). This model enables the systematic and organised distribution of learning objects based on curriculum objectives. At the university level, the model is just beginning to be implemented, with legacy issues having deterred the penetration of the LCMS and learning objects model up until recently. Most Australian universities use *Blackboard* LCMS, which allows the integration of learning objects. These can be embedded as flash or Silverlight objects following e-Ludic learning principles, as in the case of the Learning Federation. The integration of learning objects is a process that is currently being debated by higher learning institutions in Australia and worldwide.

Some significant issues can be seen to arise with regard to the implications of the thesis for low-ICT aware regional development. The cost of infrastructure development is drastically reduced through the use of online connectivity. Technological advancement takes place in the majority of underdeveloped regions that adapt ICT and learning strategies (Gutterman et al., 2009). Governments and societies must therefore work together to implement frameworks for the implementation of ITC-awareness systems.

In the case of Digital Puebla, I suggested that the government implement an e-Ludic learning objects solution using open-source LCMS. While their response has been slow, they are beginning to integrate *Moodle* as the LCMS platform to deliver e-Ludic learning objects. The results of this process will eventually be rolled out to other low-ICT aware regions in Mexico.

7.4 APPLICATIONS: E-LUDIC LEARNING OBJECTS

7.5 E-Ludic Learning Object Model

I have referred to learning objects in the previous section. There is no precise definition of what a learning object is (Wiley, 2006). Kay and Knaack (2005) define learning objects as "reusable, interactive web-based tools that support the learning of specific concepts by enhancing, amplifying, and guiding the cognitive processes of learners" (pg. 230). This definition uses the term *reusable* which, technically speaking, refers to *interoperability*. Thus, a learning object is a collection of digital resources that are used and re-used for learning purposes (Det, 2010). I characterise learning objects as interoperable web-based content units supported by multimedia and pedagogical tools to convey learning. In that vein of thought, I define e-Ludic learning objects as learning objects that incorporate play into the content. These ludic objects, I suggest, must be structured according to the e-Ludic learning object model (Figure 45). The Learning Federation examples described above adhere to this model.

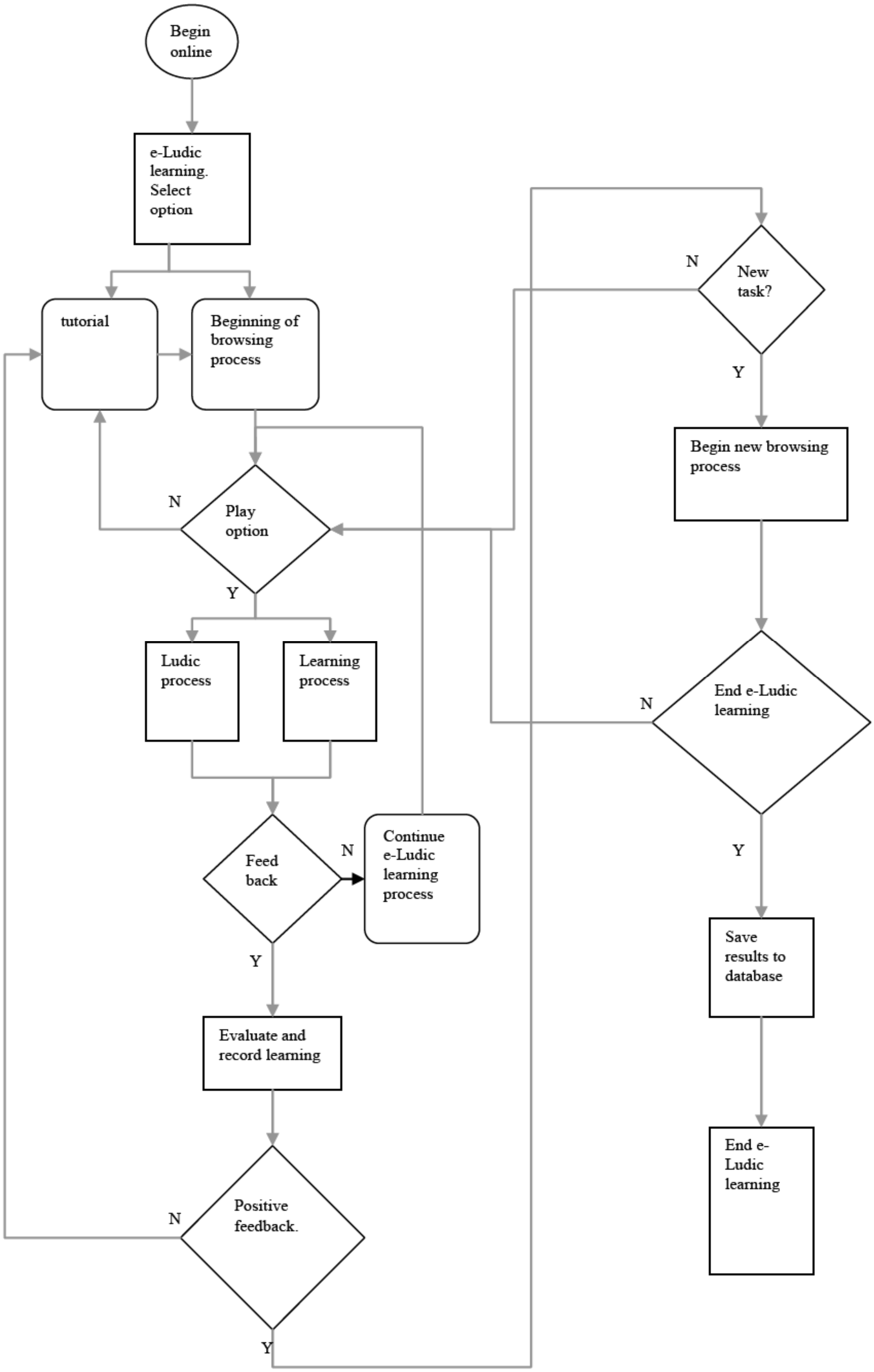

Begin online
e-Ludic learning. Select option
tutorial
Beginning of browsing process
N
Play option
Y
Ludic process
Learning process
Feed back
N
Continue e-Ludic learning process
Y
Evaluate and record learning
N
Positive feedback.
Y
N
New task?
Y
Begin new browsing process
N
End e-Ludic learning
Y
Save results to database
End e-Ludic learning

Figure 45. E-Ludic learning object model (Chang and Kung, 2005)

The model explains the interface of an e-Ludic learning object. First, when the user begins the learning object he/she has the choice of either viewing the tutorial, or playing the learning material directly. The moment the play option is selected, the learning and playing processes are activated. The user can then opt to continue playing, or to receive feedback on his/her progress. If the user receives positive feedback, he/she has the choice to go to the next learning-play task. If the user opts not to do so, then he/she can return to the previous level. If the user decides to tackle the next task then he/she is directed to a new browsing process. In the new stage the user can end the game or continue with the process in a loop fashion. The play option triggers the playing and learning processes.

The learning process must happen according to the learning theory and methodology employed in the application designed. In the case of LHADP, the learning theory was automaticity. The children achieved automaticity the moment they were able to browse the application faster. The provision of feedback by the system, as indicated in the model, is fundamental to the learning process. The option to return to the tutorial was provided in LHADP. This reinforces the learning process and bridges any possible learning gaps.

The playing process must generate emotions in the user through playful activities (Figure 46). Each of the activities generate corresponding emotions, which develop engagement on the part of the user. The maximum state of engagement is *flow*, where the user experiences complete absorption in the content. This content is presented in a defined format so as to maximize the learning process.

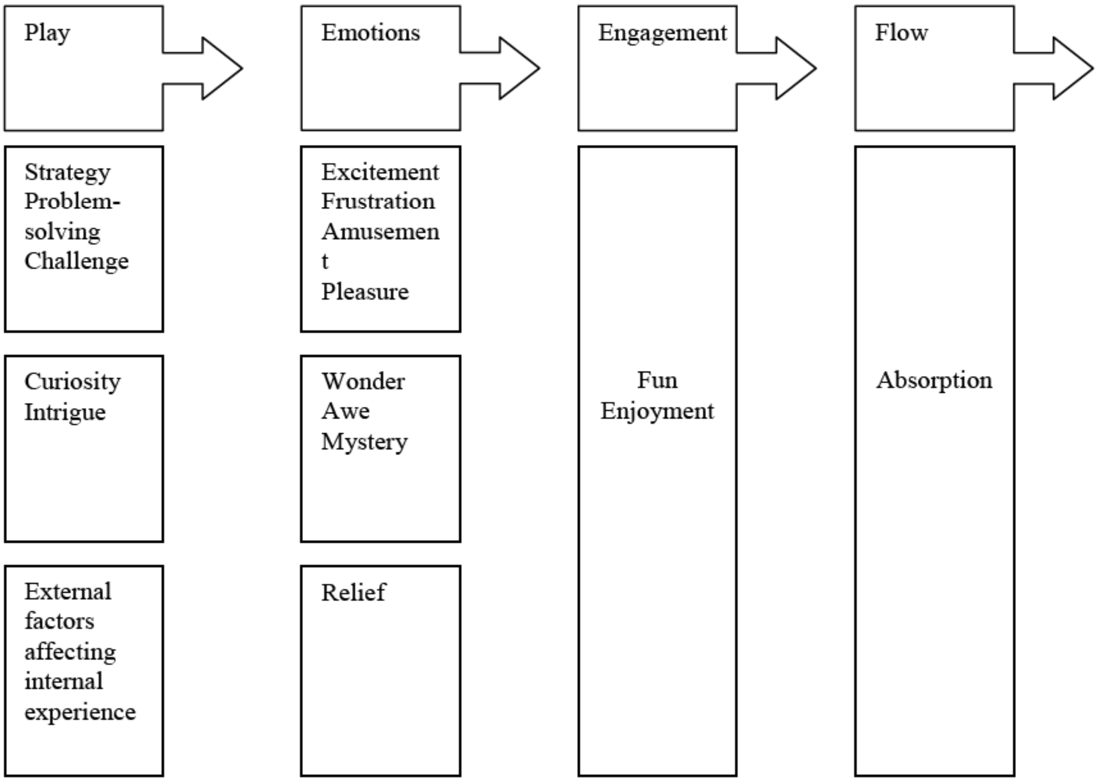


Figure 46. Playing process

The aim of the learning process is to activate any of the three types of thought process that dominate the human mind: abstraction, creation, and emotional thinking. Each thinking process is linked to different learning philosophies. Abstract thinking is related to symbolic learning, emotional thinking veers towards experiential learning, and creative thinking relates to associative learning methods.

7.6 CONCLUSIONS

E-Ludic learning is the result of the convergence of different technological advances and educational developments over the past 20 years. These advances and developments are depicted in the model in Figure 47. It represents each of the different elements that have been amalgamated to conceptualise e-Ludic learning. The model appeared as a mind map in each chapter and is presented in this conclusion as a process model. Each arrow indicates the evolution of a specific element contained in the text boxes. The arrow intersections indicate the amalgamation of different elements and the term coined as a result. Elements connected with dashed lines indicate ramifications and sub-domains. Those elements connected with dots and no arrows represent conditions that have to be met to achieve the dissemination of e-Ludic learning environments in low ICT-aware regions in particular.

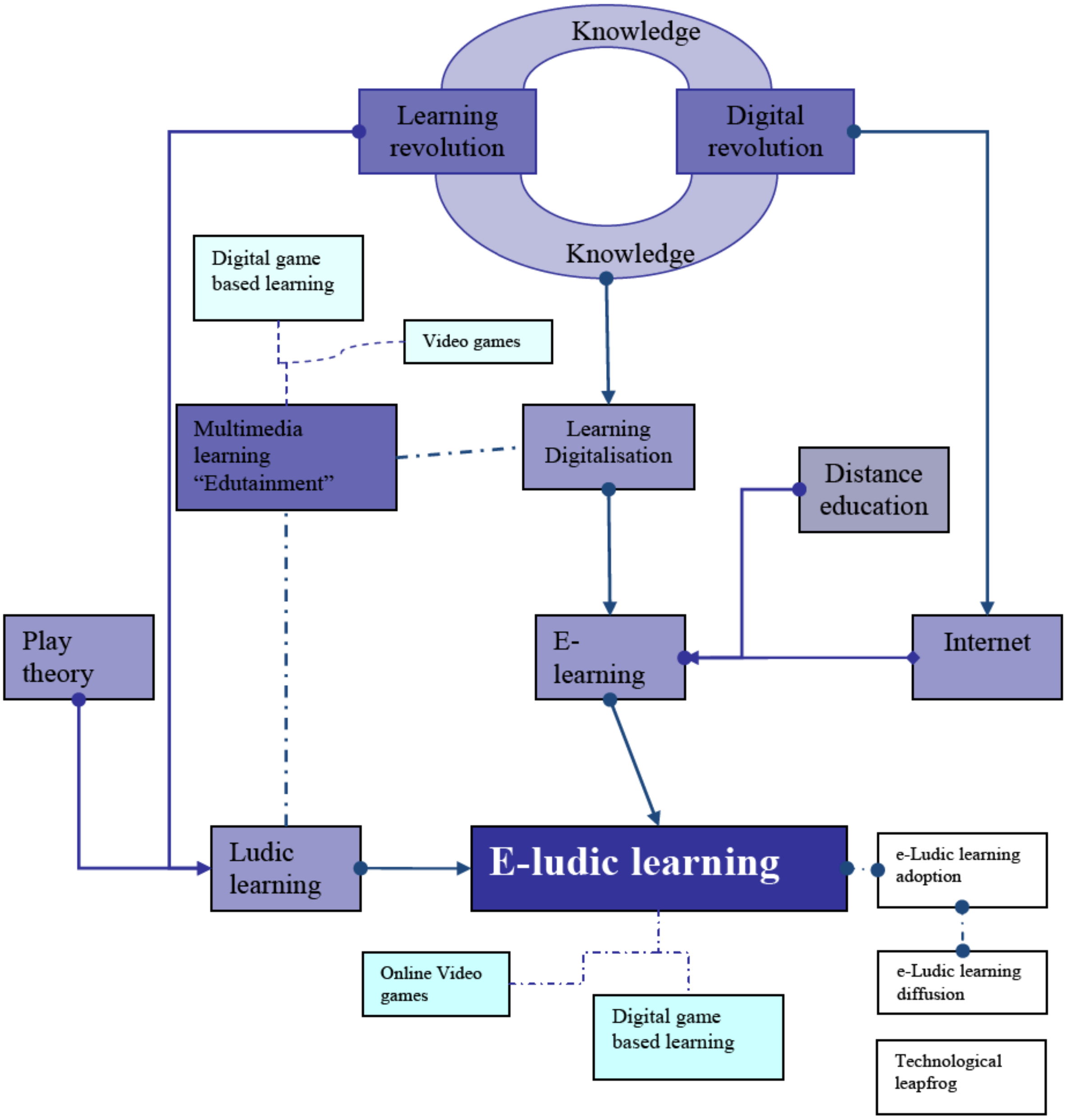


Figure 47. E-Ludic learning model evolution

This research met the conditions mentioned and demonstrated that e-Ludic learning is an effective learning tool that can be used as an alternative to traditional methods of education. It has also demonstrated that governments need not invest exorbitant amounts of money in school infrastructure. Only modest investments in Internet accessibility, ICT equipment, and basic staff training are required to achieve the desired educational outcomes. E-Ludic content can be developed by interdisciplinary teams and distributed on a large scale to diverse regions through an LCMS, via learning objects. This process has the potential to save public money and to produce technological leapfrogs.

Based on this research, I conclude that the integration of e-Ludic learning objects into LCMSs is the future of both educational technology and public policy for social development. The author has been personally involved in setting up LCMS systems like *Moodle* and *Blackboard*, and one of the main demands on the part of users has been the delivery of ludic learning content as part of the online lesson structure. No doubt some academics and educational policy makers remain unconvinced about the benefits of the advancement of gaming and play in education (Gee, 2007). Nonetheless, sound educational design will have to address itself to the learning styles of younger generations who have grown-up immersed in e-Ludic environments worldwide.

The future of e-Ludic learning is directly linked to the future of play and gaming in education. Klopfer et al. (2009) explain that there are currently two camps in game design for education. One camp takes a technological determinist approach towards games, seeing the school curriculum as a limitation, and game playing as the best means of providing the skills required in the digital economy. The other camp aims at incorporating games into the school curriculum. This camp visualises game design in education as transcending the limitations of contemporary school curricula. Klopfer et al. (2009) suggest that these two camps should negotiate a common approach whereby play and content have the same relevance. Educational game design must include a playful element in the content it wants to deliver. Fun can be incorporated into any given content if properly identified, without detriment to content quality and the learning style of the user. Klopfer et al. (2009) believe that "educational games should put players in touch with what is fundamentally engaging about the subject" (pg. 32). The e-Ludic learning environment tested in this thesis identified an engaging and playful element in basic arithmetic instruction.

According to the Klopfer et al. (2009), content design is not the only challenge for the adoption of educational games. They consider curriculum requirements, attitudes, logistics and infrastructure, support for teachers, assessment tools, research and anecdotal use, limited views, and socio-cultural factors, as the obstacles for game adoption in educational settings. Educators and game designers must find common ground as long as present generations continue to be the driving force behind game content adoption. The knowledge economy, and its attendant need for a productive workforce, will increasingly necessitate that educational departments worldwide search for the best ways to educate their populations.

This thesis has demonstrated that low ITC-aware learners have similar perceptions of gaming to their peers in more technologically advanced regions. In the case of low ICT-aware regions, the goal is to achieve a technological leapfrog by harnessing the educational potential of digital technology, and thereby develop pre-industrial regions into digital economic zones. This fundamental principle must be the impetus for developing countries to adopt e-Ludic learning in development policy as a matter of urgency. This research has been an attempt to provide a cost-effective model to that end.

REFERENCES

Adcock, A. (2008). *Making Digital Game-based Learning Work: An Instructional Designer's Perspective*. Library Media Connection, 26(5), 56–57.

Akshaya (2005). *Project Objectives*. Retrived August 22, 2005, from http://210.212.236.212/akshaya/objectives.html

Akshaya (2008). *In the News*. Retrieved June 18, 2009, from http://210.212.239.84/akshayaweb/in_news.html

Aleven, V., Stahl, E., Schworm, S., Fischer, F. & Wallace (2003). *Help Seek and Help Design in Interactive* Review of Educational Research, 73(3), 277-320.

Alvarez, A. & Pages, L. (1999) translation from Barry M. L. *Una Breve Historia de Internet, Segunda Parte* [Brief Internet History, Part Two]. Retrieved January 2, 2002, from http://.www.ati.es/DOCS/internet/histint/histint2.html.

Alvarez, A. & Pages, L. (1999) translators from Barry M. L, et al. *Una breve historia de Internet, Primera Parte* [Brief Internet History, Part One]. Retrieved January 2, 2002, from http://.www.ati.es/DOCS/internet/histint/histint1.html.

Ambient Insight Research (2008). *The US Corporate Market for Self-paced eLearning Products and Services: 2008-2013 Forecast and Analysis. The recession is a growth catalyst for certain types of products and services*. October 2008

Anderson, G. (2003). *Violent Video Games: Myths, Facts, and Unanswered Questions*. Retrieved June 8, 2005 from http://www.apa.org/science/about/psa/2003/10/anderson.aspx

Andresen & Ahdell (2001). *Games and Simulations in Workplace eLearning: How to align eLearning content with learner needs*. Retrieved April 8, 2002, from http://.www.twitchedspeed.com/site/download/thesis_final.pdf.

Applefield, J.M., Huber, R. & Moallem, M. (2000). *Constructivism in theory and practice: Toward a better understanding*. The High School Journal, 82(4), 35-43.

Application Planet (2001). *Companies Moving Towards E- learning*. Retrieved September 8, 2002, from http://www.applicationplanet.com/facts/elearning_cyberatlas.html.

Asirvatham, D. (2005). *Effective E-learning Content Management and Delivery: Multimedia University's Experience*. Multimedia University. Retrieved June 19, 2008, from: http://asiapacific-odl.oum.edu.my/C33/F226.pdf

Austrade (2009). *ICT to Mexico*. Retrieved March 22, 2010, from: http://www.austrade.gov.au/ICT-to-Mexico/default.aspx

Bandura, A. (1977). *Social Learning Theory*. Englewood Cliffs, N.J.: Prentice-Hall.

Barkin, G. (2002). *Culture in Civilization III*. Joystick101.org. Retrieved October 10, 2003, from www. Joystick101.org/story/2002/1/12/222013/422

Barrantes, R. (2007). *Analysis of ICT Demand: What Is Digital Poverty and How to Measure It?* In H. Galperin and J. Mariscal (eds). Digital Poverty: Latin American and Caribbean Perspectives. Ottawa, On: International Development Research Centre.

Barron, H.S. (2004). *La Educacion en línea en Mexico [Online Education in Mexico]*. Edutec Revista Electronica de Tecnologia Educativa, 18. Retrieved October 3, 2009, from http://www.uib.es/depart/gte/edutec-e/revelec18/barron_18.htm

Bates, A. (2005). *Technology, E-learning and Distance Education*. London: Routledge.

Baumgartner, P. (2001). *Webbasierte Lernumgebungen – neue Ansätze zum Politiklernen.*Publication of Traditionelle und Neue Medien im Politikunterricht der Schriftenreihe der Bundeszentrale für politische Bildung. Retrieved July 9, 2005, from http://iol1.uibk.ac.at/php/documents/pdf/VLEs-lang1.pdf

BBFC (2007) *News*. Retrieved May 23, 2009, from http://www.bbfc.co.uk/news/stories/20070417.html

Becker, K. (2007). *Digital game-based learning once removed: Teaching teachers*. British Journal of Educational Technology, 36(3), 478-488.

Becker, L. (2001). *Effect Size (ES)*. Retrieved March 17, 2005, from http://web.uccs.edu/lbecker/Psy590/es.htm

Berson, M.J. (1996). *Effectiveness of Computer Technology in the Social Studies: A Review of the Literature.* Journal of Research on Computing in Education, 28 (4), 486-99.

Blanchard, K. and Cheska, A. (1985). *An Anthropology of Sport: An Introduction.* Massachusetts: Bergin and Garvey Publisher.

Bloom, B. S. (1986). *Automaticity: The Hands and Feet of Genius.* Educational Leadership, 43 (5), 70-77.

Braden, R. A. (1996). *The case for linear instructional design and development: A commentary on models, challenges, and myths*. Educational Technology, 5-23.

Bradshaw, L. (2002). *Case Study: Sim City*. Presentation made to the Markle Foundation. Retrieved January 31, 2002, from http://www.markle.org/News/SimCity01-31-02.pps

Brand, J. & Knight, S. (2001). *Guidelines Review on Behalf of the Office of Film and Literature Classification*. Centre for New Media Research and Education. Australia: Bond University.

Brand, J. (2000). *Communication Technology: Policy and Planning*. Lecture delivered in the class New Communication Technologies. Australia: Bond University.

Brand, J. (2001). *Video games as Communication*. Lecture- seminar. Bond University Australia.

Bridges (2005). *About Bridges*. Retrieved July 6, 2005, from http://www.bridges.org/about

Broderbund (2003). *Education and Reference Software*. Retrieved January 3, 2004, from http://www.broderbund.com/jump.jsp?itemType=CATEGORY&itemID=8&path=1%2C2%2C8

Brody, H (1993). *Video Games can Teach?* Technology Review, 96(8), 50- 57.

Brougere, G. (1999). *Some elements relating to children's play and adult simulation/gaming.* Simulation & Gaming, 30(2), 134-146.

Brown, D. & Lewis, J. (1968). *The Process of Conceptualization; some fundamental principles of learning useful in teaching with or without the participation of computers*. Educational Policy Research Center, Stanford Research Institute, Menlo Park, California, pp.. 16-18.

Bryce, J. (2001). *The Technological Transformation of Leisure.* Social Sciences Comprehensive Review, 19(1), 7-16.

Buderi, Robert (2000). *Engines of Tomorrow: How the World's Best Companies are using their Research Labs to Win the Future*. New York: Simon & Schuster.

Bustos, B., Keim, D.A., Saupe, D., Schreck, T. & Vranic, D. V. (2005). *Feature-based similarity search in 3D object databases*. ACM Comput. Surv. 37(4): 345-387.

Cairncross, Frances (1998). *The Death of Distance*. Melbourne: Orion Business Books.

Calao, J., & Din, F. (2001). *The Effects of Playing Educational Video games on Kindergarten achievement*. Child Study journal, 31(2), 95-101.

Campbell and Schulz, (2002) -*done it is.* (Mann, Newhouse, Pagram, Campbell & Schulz 2002).

Canal software (2001). *Canal Software Interview by Aguilera and Romero*. Retrieved March 8, 2001, from http://.www.canalsoftwaremexico.com/entrevistas

Canal software (2001). *Canal Software website*. Retrieved March 8, 2001, from http://.www.canalsoftwaremexico.com

Capurro, R. (2003) *The concept of information*. In: Blaise Cronin (ed) Annual Review of Information Science and Technology, 37(8), 343–411.

Carpenter, Brian (1996). *What does the IBA do anyway?* Retrieved April 12, 2001, from http://.www.iab.org/iab/connexions.html.

CEC (2001). *e-Inclusion: The Information Society's Potential for Social Inclusion in Europe [with the support of the High Level Group 'Employment and Social Dimension of the Information Society' (ESDIS)]*. European Commission, Brussels. Retrieved March 5, 2008, from http://actrav.itcilo.org/actrav-english/telearn/global/ilo/seura/euliv1.htm

Chambers, V. & Leland, J. (1999). *Generation N. Raised On Rock And Ricky Martin, The Latin Gen X Is Cruising The American Mainstream, Rediscovering Their Roots And Inventing A New, Bicultural Identity --Without Losing Anything In The Translation*. Newsweek Magazine. Retrieved November 3, 2009, from http://www.newsweek.com/id/88899

Chandler, D. (19944). *The Transition Model of Communication*. Retrieved November 23, 2009, from http://www.aber.ac.uk/media/Documents/short/trans.html

Chang, Z. & Kung, K. (2005). *Computer game combined progressive language learning system.* U.S. Patent No. 20050208459A1. Washington, DC : US Patent and Trademark Office.

Chen, S.J. (2007). *Instructional Design Strategies for Intensive Online Courses: An Objectivist-Constructivist Blended Approach.* Journal of Interactive Online Learning, 6(1), 72-86.

CIA World Fact Book (2003). *United States country profile*. Retrieved September 1, 2004, from https://www.cia.gov/cia/publications/factbook/geos/us.html

Cisco e- learning FAQ (2001). *General Questions about e-learning*. Retrieved September 8, 2002, from http://.www.cisco.com/warp/public/10/wwtraining/elearning/educate/e-learning_faq.pdf.

Cisco Systems (2001). *Fact & Statistics About e-learning*. Retrieved September 8, 2002, from http://resources.cisco.com/app/tree.taf?asset_id=48263&section_id=47982&level=two&public_view=true

Clegg, A.A. (1991). *Games and simulations in social studies education.* In Shaver, J. P., (Ed). Handbook of research on social studies teaching and learning. New York: Macmillan, pp. 523-528.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences (2nd ed.)*. Hillsdale, New Jersey: Lawrence Earlbaum Associates.

College Board (2006). *SAT frequently asked questions*. Retrieved March 6, 2006, from http://www.collegeboard.com/newsat/index.html

Completion efficiency rate per State base on gender and academic level- 2000. (2003). Retrieved March 12, 2004, from http://www.inegi.gob.mx/est/contenidos/espanol/tematicos/mediano/med.asp?t=medu23&c=4016&e=21

Conacyt (2003*) Evolution of Internet in Mexico*. Retrieved January 22, 2004, from http://www.conacyt.mx/evolucion_internet

CONAPO. (1994). *Evolución de las ciudades de México, 1900-1990*. Mexico: CONAPO-FNUAP.

Crawford, K. (1996). *Vygotskian approaches in human development in the information era*. Educational Studies in Mathematics, 31(1-2), 43-62

Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal experience*. New York: Harper and Row.

Cumming, J.J., & Elkins, J. (1999). *Lack of automaticity in the basic addition facts as a characteristic of arithmetic learning problems and instructional needs.* Mathematical Cognition, 5(2), 149-180.

Dacey, J.S. & Travers, J.F. (1996). *Human development: Across the lifespan (3rd ed.)*. Dubuque, IA: Brown and Benchmark.

DDN (2005). *About DDN.* Retrieved October 6, 2005, from http://www.digitaldivide.net/about/

Det (2010). *Learning Objects*. Retrieved March 9, 2010, from http://www.det.wa.edu.au/education/cmis/eval/curriculum/learningobjects/

Diaz, D. P. & Bontenbal, K. F. (2000). *Pedagogy-based technology training*. In P. Hoffman, and D. Lemke (Eds.), Teaching and Learning in a Network World, (pp. 50-54). Amsterdam, Netherlands: IOS Press

Dick, W. (1995). *Instructional design and creativity: A response to the critics.* Educational Technology, (35)4, 5-11

Digest of Education Statistics (2009). *Introduction*. National Center for Education Statistics. Retrieved March 20, 2010, from http://nces.ed.gov/programs/digest/d09/

Digital Puebla Portal. Retrieved March 25, 2003, from http://www.puebla.gob.mx/politicas/bienvenida.html

Distance Education in Mexico (2005). *Distance Education in Mexico SEP portal*. Retrieved June 11, 2006, from http://www.sep.gob.mx/wb2

Dix, A. (2003) *Being playful – learning from children.* In Proceedings of Interaction Design and Children 2003. Preston: UK.

Dlodlo, N. (2009). *Access to ICT education for girls and women in rural South Africa: a case study*. Technology in Society, 31(2), 1-12.

Dominguez, L. C. (2002). *Educational video games for the e-Mexico project.* Unpublished Master Dissertation. Australia: Bond University.

Dorman, S. (1997). *Video and Computer games: effect on children and implications for health education.* The Journal of School Health, 67, 133- 8.

Driscoll, M. P. (1994). *Psychology of learning for instruction.* Boston: Allyn and Bacon.

Driscoll, M. P. (2003). *The Strategic Impact of Corporate Learning*. CLO Magazine. Retrieved April 25, 2004, from http://www.clomedia.com/content/templates/clo_feature_hc.asp?articleid=134&zoneid=56

Duffy, T. M., & Jonassen, D. H. (1991). *Constructivism: New implications for instructional technolgy?* Educational Technology, 31(5), 7-11.

Dugard, P., & Todman, J. (1995). *Analysis of Pre-test Post-test control group designs in educational research.* Educational Psychology, 15(2), 181-198.

Dwyer, T., & Crithfield, M. (1978). *BASIC and the personal computer Reading*. MA: Addison-Wesley

Eastmond, D. (2000). *Realizing the Promise of Distance Education in Low Technology Countries.* Washington: Educational Technology, Research and Development.

Edgens, J., Nickel, P. & Morey, E. (2003). *Edutainment: Critical Inquiry, Reading, Writing and Speaking in Large Environment and Natural Resource Survey Courses*. Retrieved May 15, 2004, from http://www.snr.missouri.edu/meetings/uenr/Edgens.pdf

Egan, K. (1997). *The educated mind: How Cognitive Tools Shape Our Understanding*. Chicago: University of Chicago Press.

eGovernment (2005). *eGovernment website*. Retrieved June 6, 2005, from http://www.egov4dev.org/

Elearnframe report (2000). *Facts, Figures & Foces Behind e- Learning*. Retrieved August 4, 2002, from http://.www.learnframe.com/aboutelearning/elearningfacts.pdf.

El-Khouly, M. (2008). *CD-ROM Use in e-Learning. European Journal of Open, Distance nd e-learning*. Retrieved December 20, 2009, from http://www.eurodl.org/?keyword=e-learning&article=339

eMarketer report (2009). Mexico online. New York: eMarketer, Inc.

e-Mexico (2005). *E-Mexico portal*. Retrieved September 9, 2002, from http://www.e-mexico.gob.mx/wb2

e-Mexico (2008). *The e-Mexico Portal*. Retrieved July 12, 2009, from http://www.e-mexico.gob.mx/

ESA (2008) *Game Player Data*. Retrieved June 2, 2009, from http://www.theesa.com/facts/gameplayer.asp

ESA (2008). *Sales and Genre*. Retrieved June 2, 2009, from http://www.theesa.com/facts/salesandgenre.asp

Eva Kaplan- Leiserson (2001). *E- learning Glossary*. Learning Circuits.: Retrieved December 4, 2002, from http://.www.learningcircuits.org/glossary.html.

Faulkner, J. (2005). *It's Not Just Fun and Games, Teaching You Know: Engagement, Learning and Classroom Practice*. Paper published in Conference proceedings LERN June 27-30, Havana, Cuba.

Ferguson, D. A., and Perse, E. M. (2000). *The World Wide Web as a functional alternative to television.* Journal of Broadcasting & Electronic Media, 44(2), 155-174.

Ferris, Pixy (1997). *Computer Mediated Communication.* Retrieved March 16, 2002, from http://.www.december.com/cmc/mag/1997/jan/ferris.html.

Finn Jr, Chester E. & Ravitch, D. (1996). *Part IV: The Tyranny of Dogma. A Report from the Educational Excellence Network to its Policy Committee and the American People, Education Reform 1995- 1996*. Retrieved November 23, 2002, from http://.www.edexcellence.net/library/epctoc.html.

Fister, S. (1999). *CBT fun and games*. Training Magazine, 36(5), 68-70.

Florida, R. (2002). *The Rise of the Creative Class: And How It's Transforming Work, Leisure, Community and Everyday Life*. New York: Basic Books.

Forrester research (2000) quoted Andresen & Ahdell (2001). *Games and Simulations in workplace eLearning "How to align eLearning content with learner needs"*. Retrieved April 8, 2002, from http://.www.twitchedspeed.com/site/download/thesis_final.pdf.

Fosnot, C.T. (1996). *Constructivism: A psychological theory of learning*. In C. T. Fosnot (Ed.), Constructivism: Theory, Perspectives, and Practice. New York: Teachers Collage

Frasca, G. (1998). *Don't play it again, Sam: One-session games of Narration.* Retrieved May 22, 2004, from http://cmc.uib.no/dac98/papers/frasca.html

Funbrain (2005). *About Us*. Retrieved April 9, 2005, from http://www.funbrain.com/aboutus.html

Funk, J.B. & Buchman, D.D. (1995). *Video game controversies.* Pediatric Anals, 24(2), 91-94.

Funschool (2004). *About this site.* Retrieved June 8, 2005, from http://corporate.kaboose.com/properties.html

Gagné , R. M. & Glaser, R. (1987). *Foundations in learning research*. In R.M. Gagné (Ed.), Instructional technology: Foundations. Hillsdale, NJ: Lawrence Erlbaum Associates.

Gagné , R. M., Briggs, L. J., & Wager, W. W. (1988). *Principles of instructional design (3rd ed.)*. Fort Worth, TX: Holt, Rinehart, and Winston.

Games-to-Teach project (2003). *MIT Media Innitiative.* Retrieved June 6, 2004, from http://cms.mit.edu/games/education/

Garnett, D. (1999). *The Marines Corps Institute…doing more for the 'learning machine'*. Marine Corps Gazette-Quantico, 5, 2-3.

Garrido, G.B. (2005). *The Human Rights Face of Information and Communication Technology (ICT) in Mexico : How Fair is the Reality?* Revue Quebecoise de Droit international [Quebec magazine of international law], 18(1), 95-105.

Garson, D. (2004). *Univariate GLM, ANOVA, and ANCOVA.* Retrieved August 15, 2004, from http://www2.chass.ncsu.edu/garson/PA765/anova.htm

Gee, J (2003). *What Video Games Have to Teach us About Literacy and Learning.* New York: Palgrave Macmillan.

Gee, P. (2007). *What Video Games Have to Teach Us About Learning and Literacy. 2nd Edition: Revised and Updated Edition.* New York: Palgrave MacMillan.

Glickman, C.D. (1984). *Play in public School Settings: A philosophical question. T. D. Yawkey and A. D. Pellegrini (Eds), Child's play: Developmental and Applied.* Hillsdale, N. J. Lawrence Erlbaum Associates.

Graham, G. (2007). *Behaviourism*. Stanford Encyclopaedia of Philosophy. Retrieved January, 10, 2010 from http://plato.stanford.edu/entries/behaviorism/

Greenspan, S. (1997) quoted in Price, E. (1998). *Instructional systems design and the affective domain.* Educational Technology, 38(6), 17-28.

Greenwald, J. (1999). *Retraining your brain*. New York: Time.

Grieve, J. (2003). *Neuropsychology for Occupational Therapists*. 2nd Edition. New York: Wiley-Blackwell.

Griffiths, M. (1999). *Violent Video Games and Agression: A Review of the Literature.* Aggression and Violent Behaviour, 4(2), 203- 212.

Gross, N. (1996, Dec. 23). *Zap! Splat! Smarts?* Business Week, 64- 69.

Gutterman, B., Rahman, S., Supelano, J., Thies L. & Yang, M. Advisor: Ambassador Rafat Mahdi (2009). *ICT in Education for development* [White paper]. Retrieved March 9, 2010, from http://unpan1.un.org/intradoc/groups/public/documents/gaid/unpan034975.pdf

Hassenburg, A. (2009). *Distance Education Versus The Traditional Classroom*. Berkeley Scientific Journal, 13(1). Retrieved November 28, 2009, from: http://escholarship.org/uc/item/3859m52h

Haughey, M. & Muirhead, B. (2005). *Evaluating Learning Objects for Schools*. *E-Journal of Instructional Science and Technology*, 8(1). Retrieved February 19, 2010, from: http://www.usq.edu.au/electpub/e-jist/docs/vol8_no1/fullpapers/eval_learnobjects_school.htm

Hearn, G., Mandeville, T. & Anthony, D. (1998). *The Communication Superhighway*. Australia: Allen & Unwin.

Hedberg, J. (1997). *Creating Motivating Interactive Learning Environments.* University of Wollongong. Retrieved October 10, 2003, from http://crm.hct.ac.ae/020hedberg.html.

Herz, J.C. (1997). *Joystick Nation.* London: Abacus.

Hesmondhalgh, D. (2002). *The Cultural Industries.* London: Sage

Hilbert, M. R. (2001). *From Industrial Economics To Digital Economics: An Introduction To The Transition.* Santiago de Chile: CEPAL. Retrieved March 23, 2003, from http://www.cepal.org/publicaciones/DesarrolloProductivo/7/LCL1497P

Hilbert, M. R. (2001). *Latin America on its path into the digital age: where are we?* Serie Desarrollo Productivo 104. Chile: ECLAC

Hobbes Z., R. (2001). *Hobbes Internet Timetable.* Retrieved January 10, 2002, from http://.www.zakon.org/robert/internet/timeline.

Hooper, P. K. (1998). *They Have Their Own Thoughts: Children's Learning of Computational Ideas from a Cultural Constructionist Perspective.* Unpublished Ph.D. Dissertation. Cambridge, MA: MIT Media Laboratory.

Hope, W. C. (1996). *It's Time to Transform Social Studies Teaching.* Social Studies, 87(4).149-151.

Howard, J. (2002). *Eliciting Children's Perceptions of Play using the Activity Apperception Story Procedure.* Early Child Development and Care, 172 (5), 489-502.

Howard, J., Bellin, W., & Rees, V. (2003). *Exploiting Playfulness to Maximise Learning in the Early Years Classroom*. British Educational Research Association. Available through EducatiON-LINE

Huggins, R & Izushi, H. (2002). *The digital divide and ICT learning in rural communities: Examples of good practice service delivery.* Local Economy, 17, 111-122

Hunt, J., Duggirala, R., Goring, H., Williams, J., O'Leary, D., Stern, M., Blangero, J. & Almasy, L. (2000) *Genetic Basis of Variation in Carotid Artery Plaque in the San Antonio Family*

Heart Study. Retrieved March 10, 2005, from http://stroke.ahajournals.org/cgi/content/full/33/12/2775

IAC Search and Media (2000). *Press release*. Retrieved November 7, 2004, from http://www.irconnect.com/askj/pages/news_printer.html?d=11005&print=1

ILCE's History (2004) *ILCE historical review*. Retrieved May 29, 2005, from http://ilce.edu.mx/pdfs/historia_del_ilce.pdf

Imparta (2003). *About Us*. Retrieved December 23, 2005, from http://www.imparta.co.uk/.

INEGI (2002) *National Institute for Geography and Statistics, State of Puebla non- Spanish speaking population*. Retrieved November 24, 2002, from http://www.inegi.gob.mx/difusion/espanol/fbuscar.html

INEGI (2002) *National Institute for Geography and Statistics. State of Puebla total population.* Retrieved November 24, 2002, from http://pue.inegi.gob.mx/sociodem/espanol/poblacion/pob_01.html

Internet Society- Mexico (2001) *Internet in Mexico*. Retrieved September 24, 2002, from http://www.isocmex.org.mx/historia.html

Internet World Stats (2008). Retrieved April 10, 2009, from http://www.internetworldstats.com/stats.htm

Investor's Business Daily (1998) quoted on Ferguson, D. A., & Perse, E. M. (2000). *The World Wide Web as a functional alternative to television*. Journal of Broadcasting & Electronic Media, 44(2), 155-174.

Irwin, C. & Berge, Z.L. (2006). *Socialization in the online classroom*. e- Journal of Instructional Science and Technology, 9(1), 1-7.

Jenkins, H. (2001). *Game design as narrative architecture.* Retrieved November 5 2004 from http://web.mit.edu/cms/People/henry3/games&narrative.html

Jensen, E. (2000). *Brain-based learning*. San Diego, CA: The Brain Store.

Johnson, G. M. (2009). *Instructionism and Contructivism: Recociling Two Very Good Ideas*. International Journal of Special Education, 24(9), 90-98.

Jones, B., Valdez, G., Nowakowski, J., & Rasmussen, C. (1994). *Designing Learning and Technology for Educational Reform.* Oak Brook, IL: North Central Regional Educational Laboratory

Jones, G. S. (Ed) (1999). *Cibersociety 2.0: Computer Mediated Communication and Community.* London: Sage Publications.

Kail, R. V., & Cavanaugh, J. C. (2004). *Human Development: A Life-Span View*. (2nd Edition). Australia: Wadsworth publishing

Kaplan- Leiserson (2002). *E-learning dictionary compilation.* Retrieved March 6, 2005, from http://www.learningcircuits.org/glossary.html

Katz, R. (2002). *The ICT Infraestructure. A Driver of Chance*. EDUCAUSE Review, 37(4), 50-61.

Katz, S., Earl, L. & Olson, D. (2001). *The Paradox of classroom assessment: A challenge for the 21-century.* McGill Journal of Education, 36 (1), 13-26.

Kay, R. & Knaack, L. (2005). *Developing learning objects for secondary school students: A multi-component model*. Interdisciplinary Journal of Knowledge and Learning Objects*, 1,* 229-254.

Kennedy, N. (2006).*Video games gunning for bandwidth*. Retrieved December 7, 2009, from http://onpodsessions.com/2006/05/video-games-online-bandwidth.html

Keppel, G., & Zedeck, S. (1989). *Data analysis for research design: Analysis of variance and multiple regression/correlation approaches*. New York: W. H. Freeman.

Kerievsky, T. (2000). *The fun train*. Internet World, 22-24.

King, B. & Borland, J (2003). *Dungeons and Dreamers: The Rise of Computer Game Culture from Geek to Chic*. New York: McGraw-Hill Osborne Media.

Kishiyama, M., Yonelinas, A. & Knight, R., (2009) *Novelty Enhancements in Memory Are Dependent on Lateral Prefrontal Cortex.* The Journal of Neuroscience, June 24, 29(25):8114-8118.

Klett, F. (2002). *Visual Communication in Web-Based Learning Environments*. IEEE Journal of Educational Technology & Society 5 (4), 38–48.

Klopfer, E. et al. (2009) *Moving educational games forward.* Cambridge MA: MIT The Education Arcade.

Kolson, K. (1994). *The Politics of City Planning Simulations.* Paper presented at the Annual Meeting of the American Political Science Association, New York, NY, September 1-4, 1994.

Lalande, A. (1928). *Vocabulaire technique et critique de la philosophie. [Vocabulary Technique and critic of philosophy]* Paris: Librairie Félix Alcan.

Lamont, J. (2008). *E-learning: options for delivery.* KM World Magazine. Retrieved September 5, 2008, from http://www.kmworld.com/Articles/Editorial/Feature/E-learning-options-for-delivery-48971.aspx

Lawlor, M. (2001). *Topside Training Submerges Students In Virtual Reality.* SIGNAL Magazine. Retrieved April 2, 2001, from http://.www.us.net/signal/CurrentIssue/July01/topside-july.html.

Learnlink (2005). *About Learlink.* Retrieve June 6, 2005, from http://learnlink.aed.org/About/home.htm

Lee, J.L. (1994). *Effectiveness of the Use of Simulations in a Social Studies Classroom.* ERIC Documents.

Lefrancois, G. A. (1995). *Theories of Human Learning.* New York: Brooks and Cole publishing.

Leland, J. & Chambers, V (1999). *Generation Ñ.* Newsweek. Retrieved June 17, 2009, from http://www.veronicachambers.com/generation.html

Leonard, G. (1968). *Education and Ecstasy.* Berkeley: NorthAtlantic Press.

Leslie, A. (2001).*Learning: Association or computation? Introduction to a special section,* Current Directions in Psychological Science 10 (4), 124–127.

Leuhrmann, A. & Peckman, H (1984). *Computer Literacy Survival Kit.* New York: McGraw-Hill.

Linder, J. (1999). *Spark Learning with Engaging Experiences*. Retrieved March 26, 2002, from http://www.worldgame.org/mba/arthuranderson.shtml

LIS. (2005). *Alliance for the Information Society*. Retrieved August 4, 2005, from http://ec.europa.eu/europeaid/projects/alis/index_en.htm

LittleJohn (1992). *Theories of Human Communication.* California: Wadsworth publishing.

Logan, G.D., Taylor, S.E., & Etherton, J.L. (1999). *Attention and automaticity: Toward a theoretical integration*. Psychological Research, 62, 165-181.

Loidl, S. (2006). *Benefits of e-learning-crucial factors: an evaluation based on case studies*. Retrieved November 6, 2009, from http://www.formatex.org/micte2005/84.pdf

Loveless, T., & Coughlan, J. (2004). *Can U.S. students add, subtract, multiply, and divide better than previous generations? Does it matter?* Educational Leadership, 65(1), 55-59.

Macapanpan, A. (1998) quoted in Ramos (2001) *E- learning not effective for everyone.* Metro Manila: Computerworld Philippines, 10-11.

MacPherson, L. (1999). *Joystick not included*. Alexandria: Water Environment & Technology.

Malone, S. (2003). *Developing Mind Skills in Managers.* Arizona: Infinity Books.

Mann, B., Newhouse, P. & Pagram, J., Campbell, A. & Schulz, H. (2002). *Comparing auditory and textual presentations in a multimedia learning environment.* Journal of Computer-Assisted Learning, 18(3), 296 - 308.

Mariscal, J., Bonina, C. & Luna, J. (2007). *New Market Scenarios in Latin America*. In H. Galperin and J. Mariscal (eds). Digital Poverty: Latin American and Caribbean Perspectives. Ottawa, On: International Development Research Centre.

Martens, R., Bastiaens, T., & Kirschner, P. A. (2007). *New learning design in distance education: The impact on student perception and motivation*. Distance Education, 28(1), 81-93.

Martinez, F. (2008). *La Telesecundaria Mexicana. Desarrollo y problemática actual.* National Institute for Educational Evaluation. Retrieved July 25, 2009, from http://www2.inee.edu.mx/index.php?option=com_content&view=article&id=3704&Itemid=1137

Mayo, M. (2004). *Two computer-based learning environments for reading and writing narratives.* Cantoni, L. and McLoughlin, C. (eds), Proc ED-MEDIA 2004

McArthur, D., Lewis, M., & Bishay, M. (1993). *The Roles of Artificial Intelligence in Education: Current Progress and Future Prospects*. RAND, Santa Monica. Retrieved June 22, 2003, from http://.www.rand.org/education/mcarthur/Papers/role.html.

McCue, A. (2007). *Boring' e-learning fails to engage staff*. ZDNet Asia. Retrieved January 19, 2010, from: http://www.zdnetasia.com/boring-e-learning-fails-to-engage-staff-62035340.htm

McInerney, F. & White, S. (2000). *Future Wealth*. New York: Truman Talley Books. St. Martin's Press.

McPherson, M.A. & Nunes, J.B. (2008). *Critical Issues for E-Learning Delivery: What May Seem Obvious Is Not Always Put into Practice*. Journal of Computer Assisted Learning, 24(5), 433-445.

McQuail, D. (2005). *McQuail's mass communication theory, 5th edition*. London: SAGE.

Medical Dictionary Online (1999). *Video games definition.* Retrieved July 2, 2000, from http://cancerweb.ncl.ac.uk/cgi-bin/omd?query=video+games

META Media Inc. (2001). *Facts and figures about e- learning*. Retrieved June 10, 2003, from http://www.metamediainc.com/facts___figures.html.

META Media Inc. (2001). *Reasons for e- learning*. Retrieved June 10, 2003, from http://www.metamediainc.com/reasons_for_e-learning.html.

Mexican Federal Police (2002). *Report about IT in Mexico presented by Luis Carlos Domínguez to different international police organizations*. Mexico City, 2002.

Miller, J. L. (1994). *Turning the Computer into the Children's Machine.* Interpersonal Computer and Technology: An Electronic Journal for the 21st Century, 2(1), 69-75.

Moe, M., Bailey, K. & Lau, R. (1999). *The book of knowledge: Investing in the Education and Training Insdustry*. Delaware: Merrill Lynch.

Mok, M., & Wheldall, K. (1995). *Some reservations about the use of the analysis of covariance ineducational research: a response to Dugard and Todman.* Educational Psychology, 15, 199-201.

Moreno-Valle, R. (2001). *Digital Puebla Presentation*. Retrieved September 4, 2004, from http://www.ahciet.net/si/ciudades_digitales/puebla/ponencias/bloque1/05MorenoValleSFDS5.ppt

Moreno, R., & Mayer, R. (1999). *Multimedia-supported metaphors for meaning making in mathematics.* Cognition & Instruction, 17(3), 215-248.

Moshman, D. (1982). *Exogenous, endogenous, and dialectal constructivism.* Developmental Review, 2, 371-384.

Negroponte. N. (1996). *Being Digital*. New York: Vintage Books.

Net value (2003). *International Internet survey.* Retrieved March 2, 2003, from http://www.netvalue.fr/survey

Newell, A. & Simon, H. A. (1972). *Human Problem Solving*. Englewood Cliffs, NJ: Prentice Hall.

Newman, J. (2004). *Video games*. London and New York: Routledge.

NIC- Mexico (2001). *Internet in Mexico history.* Retrieved October 12, 2002, from http://www.nic.mx/es/NicMexico.Historia

Nielsen Media Research (1997) quoted on Ferguson, D. A., and Perse, E. M. (2000). *The World Wide Web as a functional alternative to television.* Journal of Broadcasting & Electronic Media, 44(2), 155-174.

Norman, D. A. & Spohrer, J. C. (1996). *Learner-centered education.* Communications of the ACM, 39(4), 24-27.

OAS Educational portal (2005). *Educational Portal for the Americas*. Retrieved July 6, 2006, from http://www.educoas.org/Portal/?culture=en

Oblinger, D. (2003). *Boomers, Gen-Xers, and Millennials: Understanding the "New Students"*. Educause Review 38(4), 37-47.

OECD (2005). *E-learning in Tertiary Education*. Retrieved January 8, 2009, from http://www.cumex.org.mx/archivos/ACERVO/ElearningPolicybriefenglish.pdf

Oksa, J. & Turunen, J. (2002) *Local Community Net Evaluation Study of the Learning Upper Karelia Project*. Retrieved September 23, 2005, from http://www.smalltownnetworks.com/docs%5CBackground%20Papers%5CNorth%20Karelia%20Background%20Paper.pdf

Olson, C.K., Kutner, L.A., Baer, L., Beresin, E.V., Warner, D.E., & Nicholi, A.M. Jr. (2009). *M-rated video games and aggressive or problem behavior among young adolescent*. Applied Developmental Science, 13(4), 188-198.

Olufemi, O. (2008). *Pedagogical Approaches and Technical Subject Teaching through Internet Media.* The Electronic Journal of e-Learning, 6 (1), 53 – 66.

On- line Medical Dictionary (1998). *Definition of video game.* Retrieved March 1, 2000, from http://www.graylab.ac.uk/cgi-bin/omd?video+games.

Papert, S. & Harel, I., (1991). *Constructionism. Chapter One Situating Constructionism.* Alex Publishing Corporation, USA. Retrieved June 6, 2003, from http://.www.papert.org/articles/SituationgConstructionism.html.

Papert, S. (1981). *Mindstorms.* Brighton: Harvester Press.

Pellegrini, A. D. (Ed.). (1995). *The future of play theory: A multidisciplinary inquiry into the contributions of Brian Sutton-Smith.* Albany, NY: State University of New York Press

Philips, R. (1998). *Models of learning appropriate to educational applications of information technology*. Teaching and Learning Forum. Retrieved May, 10, 2005 from http://www.tlc.murdoch.edu.au/eddev/eddesign/modelsoflearning.html

Piaget, J. (1950). *The psychology of intelligence*. Translated from the French by Malcolm Piercy and DE Berlyne. New York: Routledge and Kegan Paul

Pinkett, R. (2000). *Bridging the Digital Divide: Sociocultural Constructionism and an Asset-Based Approach to Community Technology and Community Building.* Paper presented at the 81st Annual Meeting of the American Educational Research Association (AERA), New Orleans. Retrieved December 12, 2002, from http://llk.media.mit.edu/papers/2000/aera2000.pdf.

Pivec, M. (2007). *Play and learn: Potential of game-based learning*. British Journal of Educational Technology, 38 (3), 387-393.

Plante, J. & Beattie, D. (2004). *Connectivity and ICT integration in Canadian elementary and secondary schools: First results from the Information and Communications Technologies in Schools Survey 2003-2004*. Culture, Tourism and the Centre for Education Statistics : Research Papers.

Plato's republic (2000). *The Repiublic By Plato*. Translated by Benjamin Jowett. Retrieved October 8, 2005, from http://classics.mit.edu/Plato/republic.html

Plomp, T., Anderson, R.E. & Polydorides, G.K. (1996). *Cross-National Policies and Practices on Computers in Education*. Boston:Kluwer Academic.

Poole, S. (2000). *Trigger Happy: Videogames and the Entertainment Revolution.* New York: Arcade Publishing.

Prensky, M. (2007) *Digital Game Based Learning*.Continuum. New York: Intl Pub Group (Paperback).

Prensky, M. & Spectre, M. (1998). *Theoretical Underpinnings of Games2train* Approach. Retrieved June 7, 2001, from http://.www.games2train.com/site/html/theory.html.

Prensky, M. (1998). *Twitch Speed- Keeping Up with Young Workers.* Cover story of the January 1998 issue of The Conference Board's magazine, Across the Board. Retrieved June 10, 2001, from http://.www.twitchspeed.com.

Prensky, M. (2000). *Digital Game Based Learning*. 1st Edition. New York: McGraw Hill.

Price, E. (1998). *Instructional systems design and the affective domain*. Educational Technology, 38(6), 17-28.

Primarygames.com (2005). *About Us.* Retrieved June 13, 2005, from http://www.primarygames.com/aboutus.htm

Proenza, F. J. (2002) *e-ForAll: A Poverty Reduction Strategy for the Information Age*. Retrieved September 2, 2002, from www.techknowlogia.org/welcome.asp?IssueNumber=17.

Proudfoot, S. (2009). Sesame Street paved way to children's edutainment. Retrieved January 6, 2009, from http://www2.canada.com/victoriatimescolonist/news/arts/story.html?id=ac81beec-584d-440c-8b7f-0947c94721f4

Provenzo Jr., E.F. (1991). *Video Kids.* Chapter One, page 10.Cambridge, MA: Harvard University Press.

Puebla Digital (2008). *New Government Portal*. Retrieved July 14, 2009, from http://www.puebla.gob.mx/index.php

Quinn, C. N. (1997). *Engaging Learning.* IT Forum paper 18. University of New South Wales. Retrieved April 9, 2004, from http://itech1.coe.uga.edu/itforum/paper18/paper18.html.

Rafaeli, S. (1988). *Interactivy: From new media to communication*. In R. P. Hawkins, J. M. Wiemann, & S. Pingree (Eds.). Sage Annual Review of Communication Research: Advancing Communication Science: Merging Mass and Interpersonal Processes, 16, 110-134. Beverly Hills: Sage.

Rahman, A. (2006). *Bridging the Digital DivideBridging Divide--- Science & Technology as Engine for Socio economic Development. Commision on Science and Technology for Development*. Ninth Session, Geneva, 15-19 May, 2006. Retrieved March 20, 2009, from: http://www.unctad.org/sections/wcmu/docs/ecn162006p17_en.pdf

Ramos, G. (2001). *E-learning not effective for everyone.* Computerworld Philippines, 12, 6-9.

Reese, S. (1999). *The New Wave of Gen X workers.* Business and Health, 17 (6), 19-23.

Reigeluth, C. M. (1999). *The elaboration theory: Guidance for scope and sequence decisions.* In C. M. Reigeluth (Ed.), Instructional design theories and models: A new paradigm of instructional theory. Hillsdale, NJ: Lawrence Erlbaum Associates

Reiman, P., Freebody, P., Hornibrook, M. & Howard, S. (2009). *A study of teachers' innovation using The Le@rning Federation's digital learning resources.* Centre for Research on Computer-supported Learning and Cognition (CoCo), Faculty of Education and Social Work, The University of Sydney.

Resnick, M. (1996). *Distributed Constructionism.* Published in the proceedings of the International Conference on the Learning Sciences Association for the Advancement of Computing in Education, North-western University. Retrieved March 14, 2004, from http://llk.media.mit.edu/papers/1991/11.html.

Resnick, M., & Ocko, S. (1991). *LEGO/Logo: Learning Through and About Design.* In Harel, I., & Papert, S. (eds.). Constructionism. Norwood, NJ: Ablex Publishing.

Rhoades, C., Fowler, G.A. & Cummins, C. (2009). *Iran Cracks Down on Internet Use, Foreign Media*. The Wall Street Journal- Eastern edition, 253(140), A9.

Roberts, B. (2008). *Hard Facts About Soft Skills e-learning.* HR Magazine. Retrieved 5 September 4, 2008, from http://www.globalenglish.com/m/dl/HRMagazine-Jan2008.pdf

Robey, R. (2004). *Effect sizes in Research Manuscrpits: Selecting, Calculating and Interpreting*. Paper presented at the Annual Conference of the American Speech Language Hearing Association, Philadelphia.

Rogers, E.M. (1995). *Diffusion of innovations (4th edition)*. New York: The Free Press.

Roongta, A. & Priyadarshini, A. (2007). *ICT for Literacy Workshop for E-9 Countries*. UNESCO New Delhi and Ministry of Human Resource Development: Background paper.

Rose, C. (1985). *Accelerated Learning*. Dell Trade Paperbacks. New York: Dell Publishing.

Rosney, R. (1995). *The New Old Luddites*, IHlole Earth Review. Englewood Cliffs, N J: Prentice ttall, 374-393.

Roy, K. (2000). *The systematic conditions leading to violent human behaviour.* Journal of Applied Behavioural Sciences 36(4), 389 – 406.

Rumble, G. (1989). *Concept: On defining distance education*. American Journal of Distance Education, 3(2), 8-21.

Russ, S. W. (2003). *Play and creativity: Developmental issues*. Scandinavian Journal of Educational Research, 47, 291-303.

Russel (2001) quoted in Tyler, K. (2001). *E- learning: Not just for e- normous companies anymore*. HRMagazine, 82-88.

Saling, M. (2004). *Accelerated Learning*. Retrieved January 8, 2008, from http://www.abc.net.au/science/features/brain/

Samuels, S. J. & Flor, R. F. (1997). *The importance of automaticity for developing expertise in reading.* Reading & Writing Quarterly, 13, 107-121.

Sandford, R. (2006). *Teaching with Games: COTS games in the Classroom.* JISC Innovating e-Learning 2006: Transforming Learning Experiences. Retrieved June 24, 2009, from http://www.online-conference.net/jisc/content/Sandford%20-%20teaching%20with%20games.pdf

Santosus, M. (1998). *Nothing like the real thing.* CIO Enterprise Magazine. Retrieved June 5, 2003, from http://www.cio.com/archive/enterprise/111598_real.html.

Scala broadcast multimedia (2004). *Multimedia definition.* Retrieved June 23, 2004, from http://.www.scala.com/multimedia/multimedia-definition.html

Schneider, W., & Chein, J.M. (2003). *Controlled & automatic processing: Behavior, theory, and biological mechanisms.* Cognitive Science, 27, 525-559.

School Network (2008). *School Network impact*. Retrieved July 25, 2009, from http://redescolar.ilce.edu.mx/redescolar2008/pdfs/informe_enero_2007.pdf

School of Tomorrow (2006). *About Us.* Retrieved June, 2006, from http://www.schooloftomorrow.com/aboutus/whyace.aspx

Schwier, R. & Misanchuk, E. (1993). *Interactive multimedia instruction.* New Jersey: Educational Technology Publications.

Sesame Street Search and Learn Adventures (1998). *Creative Wonders from the Learning Company and Children Television Workshop from Sesame Street*. Edutainment CD-ROM, USA.

Shalom, F. (2004). *Sesame Street and Beyond.* New Jersey: Lawrence Erlbaum Associates.

Shaw, A. C. (1995). *Social Constructionism and the Inner City: Designing Environments for Social Development and Urban Renewal*. Unpublished Ph.D. Dissertation. Cambridge, MA: MIT Media Laboratory.

Sheff, D. (1993). *Game Over*. Chapters 1- 3. London: Coronet Books.

Sherry, J. (2001). The effects of violent video games on aggression: A meta-analysis. Human Communication Research, 27, 409-431

Sherry, J. L. (2004) *Flow and Media Enjoyment*. Communication Theory, 14*(4)*. 328-347

Sherry, L. (1996*). Issues in Distance Learning*. International Journal of Educational Telecommunications, l (4), 337- 365. Retrieved June 4, 2002, from http://carbon.cudenver.edu/~lsherry/pubs/issues.html.

Shields, C. (2003). *That's Edutainment.* District Administration 39(5), 25-28.

Siemens, G. (2004). *Learning Management Systems: The wrong place to start learning. E-learning Space*. Retrieved March 2, 2010, from: http://www.elearnspace.org/Articles/lms.htm

Siglin, J. (2000). *Play Attention—focusing in success.* Intervention in School and Clinic 36: 122-124.

Silver, S.B., & Williamson, P.A. (1987) *The effects of videogame play in young children's aggression, fantasy and prosocial behavior.* Journal of Applied Developmental Psychology, 8, 453-462.

SIMBAD (1990). *SIMBAD- INEGI database for Municipal information*. Retrieved May 16, 2005, from http://www.inegi.gob.mx/prod_serv/contenidos/espanol/simbad/default.asp?c=73

Siriginidi, R. (2008). *Achieving millennium development goals: Role of ICTS innovations in India*. Telematics and informatics, 26(2), 127-143.

Skinner, B.F. (1938). *The behavior of organisms*. New York: Appleton-Century-Crofts.

Smalltown Networks (2002). *North Karelia*. Retrieved September 23, 2005, from http://www.smalltownnetworks.com/docs%5CBackground%20Papers%5CNorth%20Karelia%20Background%20Paper.pdf

Smilansky, S. (1968). *The effects of sociodramatic play on disadvantaged preschool children.* Oxford: Wiley.

Smith, K. U. & Smith, M. (1966). *Cybernetic Principles of Learning and Educational Design.* New York: Holt Rinehart and Winston.

Smith, P.K. (1995). *Play, ethology, and education: A personal account.* A. D. Pelligrini (Ed). The future of play theory: A multidisciplinary inquiry into the contributions of Brian Sutton-Smith. Albany: State University of New York Press.

Soule, E. J. (1999). *"Internet Como Nuevo Medio de Comunicación"*. Retrieved December 9, 2000, from http://members.tripod.com/e_soule/tesis/inicio.html.

Squire, K. (2002). *Video Games in Education.* Retrieved April 7, 2004, from http://cms.mit.edu/games/education

Squire, K. (2003). *Video games in education.* International Journal of Intelligent Games & Simulation, 2(1).

State of Puebla total population 1930-2000. (2003). Retrieved March 12, 2004, from http://www.inegi.gob.mx/est/contenidos/espanol/tematicos/mediano/med.asp?t=mpob91&c=3837&e=21

Stephenson, W. (1967). *The Play Theory of Mass Communications*. Chicago & London:The University of Chicago Press,.

Steuer, J. (1995). *Defining Virtual Reality: Dimensions Determining Telepresence*. Biocca & Levy (Eds.). Communication in the Age of Virtual Reality. Hilldale, N.J: Lawrence Erlbaum.

Stone, K. (2009). *A Labor Law for the Digital Era*. Employee Responsibilities and Rights Journal, 21(2), 145-161.

Strategy Co-Pilot (2000). *Understanding Business Strategy CD-ROM disk 1 and 2*. Imparta Capability Building. London, UK.

Sutton- Smith, B. (1995). *Conclusion: The persuasive rhetorics of play*. A. D. Pelligrini (Ed). The future of play theory: A multidisciplinary inquiry into the contributions of Brian Sutton-Smith. Albany, NJ: State University of New York Press.

Tan, J., Konrad, J. & Clegg, S. (2000). *Preparing academic staff to use ICTs in support of student learning*. The International Journal for Academic Development, 5(2), 38-148.

Teague, M. & Teague, G. (1995). *Planning with computers: A social studies simulation*. Learning and Leading with Technology, 23 (1) 20-22.

Techterms (2008). Edutainment Definition. *Retrieved December 10, 2009, from* http://www.techterms.com/definition/edutainment

Teenagers and Technology (1997) quoted on Ferguson, D. A., and Perse, E. M. (2000). *The World Wide Web as a functional alternative to television.* Journal of Broadcasting & Electronic Media, 44(2), 155-174.

Tennyson, R. D., & Nielsen, M. (1998). *Complexity theory: Inclusion of the affective domain in an interactive learn-ing model for instructional design*. Educational Technology, November-December:7–12.

Terry, L. (2000). *Tech barriers to e- learning*. Forrest City: Upside Today, 10, 1-3.

The Economist (2001). *Lessons from a virtual timetable.* Retrieved September 8, 2002, from http://www.economist.com/business/displayStory.cfm?Story_ID=505047

The Free Dictionary (1999). *Definition of pleasure*. Retrieved January 8, 2003, from http://www.thefreedictionary.com/pleasure

The Jump Star Series (2003) Retrieved June 22, 2005, from www.jumpstart.com

The Learning Company (2003). *Arthur, Reading Rabbit and Carmen Sandiego most memorable characters*. Retrieved April 21, 2006, from http://www.broderbund.com/company/comp_profile.asp

The Learning Federation (2006). *Homepage*. Retrieved August 10, 2006, from http://www.thelearningfederation.edu.au/tlf2/

The Math Blaster series by Knowledge Adventure and Vivendi Universal games (2003). Retrieved November 4, 2004, from http://.www.vugames.com

The Tower (2002). *Vision.* Retrieved July 15, 2009, from http://gig.media.mit.edu/projects/tower/vision/index.html

Thiagarajan, S. (2006). *Thiagi's 100 Favorite Games*. San Francisco, CA: Pfeiffer.

Think3 (2003). *About Us*. Retrieved March 4, 2003, from http://www.think3.com/en/about_us/default.asp

Todman, J. and Dugard, P. (1995). *Analysis of pretest-posttest control group designs*. Educational Psychology, 15(2).

Tournaki, N. (2003). *The differential effects of teaching addition through strategy instruction versus drill and practice to students with and without learning disabilities.* Journal of Learning Disabilities, 36(5), 449-458.

Travinor, G. (2009). *Definition of Video games*. Retrieved February 5, 2010, from http://www.contempaesthetics.org/newvolume/pages/article.php?articleID=492

Truss, L. (2003). *Eats, Shoots & Leaves: The Zero Tolerance Approach to Punctuation*. New York: Gotham Books.

Tucker, S. (2001). *Distance Education: Better, Worse, Or As Good As Traditional Education?* Online Journal of Distance Learning Administration, 4 (4), 10-15.

Turkle, S. (1984). *The Second Self: Computers and the Human Spirit*. Granada: London.

UNDP (2005). *Information and Communication Technologies for Development*. Retrieved July 22, 2005, from http://sdnhq.undp.org/it4dev/

UNESCO (2003). *Information For All Programme*. Retrieved March 8, 2005, from http://portal.unesco.org/ci/en/ev.php-URL_ID=21291&URL_DO=DO_TOPIC&URL_SECTION=201.html

Unesco Observatory on Information Society (2005). *Akshaya Project*. Retrieved November 12, 2005, from http://www.unesco.org/webworld/portal_observatory/pages/Regions/Asia_and_Pacific/India/index.shtml

USC Survey (2009). *Online Content*. Unpublished research, University of the Sunshine Coast.

Um, E.R., Song, H. & Plass, J. (2007). *The* Effect *of Positive* Emotions *on Multimedia Learning*. In C. Montgomerie & J. Seale (Eds.), *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2007*. Chesapeake, VA: AACE.

Vichido, C., Estrada, M. & Sanchez, A. (2003). *A constructivist educational tool: Software architecture for web-based video games*. Tlaxcala, Mexico: Fourth Mexican International Conference on Computer Science.

Vidart, D. (1995). *"El juego y la condición humana. Notas para una antropología de la libertad en la necesidad."* [Play and human conditions. Notes for anthropological freedom in the need]. Motevideo: Ediciones de la Banda Oriental.

Vos, J. & Dryden, G. (2002). *The Learning Revolution.* Spanish translation. Garcia, Alma. Mexico, DF: Grupo Editorial Tomo.

Vos, J., & Dryden, G. (1999). *The Learning Revolution. To change the way the world learns.* California: The Learning Revolution Ed.

Vygotsky, L.S. (1978). *Mind in Society: The development of higher psychological processes.* M. Cole, V. JohnSteiner, S. Scribner and E. Souberman, Eds. And Trans. Cambridge, MA: Harvard University Press.

Wade, M. & Beck, J.C. (2006). *The Kids are Alright: How the Gamer Generation is Changing the Workplace*. Boston: Harvard Business Press.

Ward-Crixell, K. (2009). *Storytelling can extend beyond the covers of a book*. School Library Journal, 55(6), 29.

Weston, M. (2001) *Coaching generations in the workplace*. Nursing Administration Quarterly, 25(2), 11-21.

Wiley, D. (2005). *RIP-ping on Learning Objects*. Retrieved March 3, 2010, from http://opencontent.org/blog/archives/230

Willis, B. et al (2000). *Guide on distance education based on the books Distance Education-Strategies and Tools and Distance Education- A Practical Guide.* Edited by Tania H. Gottschalk. Retrieved January 17, 2002, from http://.www.vidaho.edu/evo/dist1.html & http://.www.vidaho.edu/evo/dist12.html.

Wilson, K. (1992). *Discussion on two multimedia R & D projects: The Plaenque project and the interactive video project of the museum education consortium.* In M. Giardina (Ed.), Interactive Multimedia learning environments (pp. 186-196). Berlin: Springer-Verlag.

Wolf, M. (2000). *Genre and the Video game.* The Medium of the Video game. University of Texas Press. Retrieved March 7, 2001, from http://.www.robinlionheart.com/gamedev/genres.xhtml.

Young, J. (2000). *Virtual Reality on a Desktop hailed as a new tool in distance education.* Washington: The Chronicle of Higher Education.

APPENDICES

Appendix 1.

Programming code for the e-Ludic learning environment

Ambiente applet-

```
import java.awt.Graphics;

import java.lang.Math;

import java.lang.Integer;

import java.awt.*;


public class Ambiente extends java.applet.Applet {

int n2=0;


public void init () {

setBackground (Color.yellow);

}

public void paint(Graphics screen) {

int Ay=0;

if (n2 == 0) return;

for (int i = 0; i < n2; i++) {

Ay= Ay + 50;

screen.fillOval(100, Ay, 30,30);

}


}
```

```
public void asig(int A2){
n2 = A2;
repaint();
}

}
```

AmbienteS applet-

```
import java.awt.Graphics;
import java.lang.Math;
import java.lang.Integer;
import java.awt.*;
import java.lang.String;

public class AmbienteS extends java.applet.Applet {

int n2=0;

public void init () {
setBackground (Color.yellow);
}

public void paint(Graphics screen) {
if (n2 == 0) return;
Font f = new Font ("Courier", Font.BOLD, 90);
screen.setFont (f);
```

```
screen.setColor (Color.red);
screen.drawString(String.valueOf(n2), 20, 200);
}

public void asig(int A2){
n2 = A2;
repaint();
}
}
```

Botones applet-

```
import java.awt.*;

public class Botones extends java.applet.Applet {
Button oneButton, twoButton, threeButton, fourButton, fiveButton,
sixButton, sevenButton, eightButton, nineButton, tenButton;
int A2=0;
int A1=0;
int valb = 0;


public void init() {

setLayout(new GridLayout(10,0,1,0));

oneButton = new Button("1");
add(oneButton);
```

```
twoButton = new Button("2");
add(twoButton);
threeButton = new Button("3");
add(threeButton);
fourButton = new Button("4");
add(fourButton);
fiveButton = new Button("5");
add(fiveButton);
sixButton = new Button("6");
add(sixButton);
sevenButton = new Button("7");
add(sevenButton);
eightButton = new Button("8");
add(eightButton);
nineButton = new Button("9");
add(nineButton);
tenButton = new Button("10");
add(tenButton);
}
public void newGame() {
A1 = (int) (java.lang.Math.random() * 5 + 1);
Environment L = (Environment)getAppletContext().getApplet("Environment");
L.asig(A1);
A2 = (int) (java.lang.Math.random() * 5 + 1);
Ambiente I = (Ambiente)getAppletContext().getApplet("Ambiente");
I.asig(A2);
Respuesta R = (Respuesta)getAppletContext().getApplet("Respuesta");
R.setRes ("Juego nuevo");
```

```
}
public boolean action(Event evt, Object arg) {
if (evt.target instanceof Button) {
String labl=(String)arg;
if (labl.equals("1")){
valb = 1;
compare(valb);
}else  if (labl.equals("2")){
valb = 2;
compare(valb);
}else   if (labl.equals("3")){
valb = 3;
compare(valb);
}else   if (labl.equals("4")){
valb = 4;
compare(valb);
}else  if (labl.equals("5")){
valb = 5;
compare(valb);
}else   if (labl.equals("6")){
valb = 6;
compare(valb);
}else if (labl.equals("7")){
valb = 7;
compare(valb);
}else if (labl.equals("8")){
valb = 8;
compare(valb);
```

```
}else if (labl.equals("9")){
valb = 9;
compare(valb);
}else if (labl.equals("10")){
valb = 10;
compare(valb);

}return true;

} else return false;
}

void compare(int sumT){
if ((A1 + A2) == sumT){
Respuesta R = (Respuesta)getAppletContext().getApplet("Respuesta");
R.setRes ("Correcto");
}else {Respuesta R = (Respuesta)getAppletContext().getApplet("Respuesta");
R.setRes ("Incorrecto");
}
}

}
```

BotoneS applet-

```
import java.awt.*;

public class BotonesS extends java.applet.Applet {
Button oneButton, twoButton, threeButton, fourButton, fiveButton,
sixButton, sevenButton, eightButton, nineButton, tenButton;
int A2=0;
int A1=0;
int valb = 0;



public void init() {

setLayout(new GridLayout(10,0,1,0));

oneButton = new Button("1");
add(oneButton);
twoButton = new Button("2");
add(twoButton);
threeButton = new Button("3");
add(threeButton);
fourButton = new Button("4");
add(fourButton);
fiveButton = new Button("5");
add(fiveButton);
sixButton = new Button("6");
add(sixButton);
```

```
sevenButton = new Button("7");
add(sevenButton);
eightButton = new Button("8");
add(eightButton);
nineButton = new Button("9");
add(nineButton);
tenButton = new Button("10");
add(tenButton);
}
public void newGame() {
A1 = (int) (java.lang.Math.random() * 5 + 1);
EnvironmentS L = (EnvironmentS)getAppletContext().getApplet("EnvironmentS");
L.asig(A1);
A2 = (int) (java.lang.Math.random() * 5 + 1);
AmbienteS I = (AmbienteS)getAppletContext().getApplet("AmbienteS");
I.asig(A2);
Respuesta R = (Respuesta)getAppletContext().getApplet("Respuesta");
R.setRes ("Juego nuevo");
}
public boolean action(Event evt, Object arg) {
if (evt.target instanceof Button) {
String labl=(String)arg;
if (labl.equals("1")){
valb = 1;
compare(valb);
}else  if (labl.equals("2")){
valb = 2;
compare(valb);
```

```
}else   if (labl.equals("3")){
valb = 3;
compare(valb);
}else   if (labl.equals("4")){
valb = 4;
compare(valb);
}else  if (labl.equals("5")){
valb = 5;
compare(valb);
}else   if (labl.equals("6")){
valb = 6;
compare(valb);
}else if (labl.equals("7")){
valb = 7;
compare(valb);
}else if (labl.equals("8")){
valb = 8;
compare(valb);
}else if (labl.equals("9")){
valb = 9;
compare(valb);
}else if (labl.equals("10")){
valb = 10;
compare(valb);

}return true;

} else return false;
```

```
}

void compare(int sumT){
if ((A1 + A2) == sumT){
Respuesta R = (Respuesta)getAppletContext().getApplet("Respuesta");
R.setRes ("Correcto");
}else {Respuesta R = (Respuesta)getAppletContext().getApplet("Respuesta");
R.setRes ("Incorrecto");
}
}

}
```

Environment applet-

```
import java.awt.Graphics;
import java.lang.Math;
import java.lang.Integer;
import java.awt.*;

public class Environment extends java.applet.Applet {

int n1=0;

public void init () {
setBackground (Color.yellow);
```

```
}
public void paint(Graphics screen) {
int Ay=0;
if (n1 == 0) return;
for (int i = 0; i < n1; i++) {
Ay= Ay + 50;
screen.fillOval(100, Ay, 30,30);
}

}
public void asig(int A1){
n1 = A1;
repaint();
}
}
```

EnvironmentS-

```
import java.awt.Graphics;
import java.lang.Math;
import java.lang.Integer;
import java.awt.*;
import java.lang.String;
public class EnvironmentS extends java.applet.Applet {

int n1=0;
```

```
public void init () {
setBackground (Color.yellow);
}

public void paint(Graphics screen) {
if (n1 == 0) return;
Font f = new Font ("Courier", Font.BOLD, 90);
screen.setFont (f);
screen.setColor (Color.red);
screen.drawString(String.valueOf(n1), 50, 200);
}


public void asig(int A1){
n1 = A1;
repaint();
}
}
```

Respuesta applet-

```
import java.applet.Applet;
import java.awt.Graphics;
import java.awt.Image;
import java.applet.AudioClip;
```

```
import java.awt.Label;
import java.awt.*;

public class Respuesta extends Applet {
String res;
String Correcto;
String Incorrecto;
Image happyface;
Image sadface;
AudioClip bien;
AudioClip mal;
public void init () {
res = new String ("");
setBackground (Color.gray);
happyface = getImage(getCodeBase(), "Superhero.gif");
sadface = getImage(getCodeBase(), "Ghost.gif");
bien = getAudioClip(getCodeBase(), "bien.wav");
mal = getAudioClip(getCodeBase(), "mal.wav");
}
public void paint ( Graphics g ) {
if (res == "Correcto"){
g.drawImage(happyface, 15, 20, this);
bien.play();
}else{
if (res == "Incorrecto"){
g.drawImage(sadface, 15, 20, this);
mal.play();
}else{g.drawString(res, 15, 20);
```

```
}
}
}
public void setRes(String aString) {
res = aString;
repaint();
}
}
```

RespuestaO applet-

```
import java.applet.Applet;
import java.awt.Graphics;
import java.awt.Label;
import java.awt.*;

public class Respuesta extends Applet {
String res;

public void init () {
res = new String ("");
setBackground ( Color.white );
}
public void paint ( Graphics g ) {
```

```
g.drawString(res, 15, 20);

}


public void setRes(String aString) {

res = aString;

repaint();

}

}
```

Texto applet-

```
import java.awt.*;


public class Texto extends java.applet.Applet {

Label AnotaRes = new Label("Anota la Respuesta");

TextField res = new TextField (10);

int A2=0;

int A1=0;

int sumT = 0;


public void init() {


setLayout(new GridLayout(2,0,15,0));

add(AnotaRes);

add(res);}
```

```
public void newGame() {

A1 = (int) (java.lang.Math.random() * 5 + 1);

Environment L = (Environment)getAppletContext().getApplet("Environment");

L.asig(A1);

A2 = (int) (java.lang.Math.random() * 5 + 1);

Ambiente I = (Ambiente)getAppletContext().getApplet("Ambiente");

I.asig(A2);

Respuesta R = (Respuesta)getAppletContext().getApplet("Respuesta");

R.setRes ("Juego nuevo");

res.setText("");

}

public boolean action(Event evt, Object arg) {

if (evt.target instanceof TextField) {

String labl=(String)arg;

compare(labl);


return true;


} else return false;

}


void compare(String b){

sumT=Integer.parseInt(b);

if ((A1 + A2) == sumT){

Respuesta R = (Respuesta)getAppletContext().getApplet("Respuesta");

R.setRes ("Correcto");

}else {Respuesta R = (Respuesta)getAppletContext().getApplet("Respuesta");
```

```
R.setRes ("Incorrecto");
}
}

}
```

TextoS applet-

```
import java.awt.*;

public class TextoS extends java.applet.Applet {
Label AnotaRes = new Label("Anota la Respuesta");
TextField res = new TextField (10);
int A2=0;
int A1=0;
int sumT = 0;


public void init() {

setLayout(new GridLayout(2,0,15,0));
add(AnotaRes);
add(res);}

public void newGame() {
A1 = (int) (java.lang.Math.random() * 5 + 1);
EnvironmentS L = (EnvironmentS)getAppletContext().getApplet("EnvironmentS");
```

```
L.asig(A1);

A2 = (int) (java.lang.Math.random() * 5 + 1);

AmbienteS I = (AmbienteS)getAppletContext().getApplet("AmbienteS");

I.asig(A2);

Respuesta R = (Respuesta)getAppletContext().getApplet("Respuesta");

R.setRes ("Juego nuevo");

res.setText("");

}

public boolean action(Event evt, Object arg) {

if (evt.target instanceof TextField) {

String labl=(String)arg;

compare(labl);


return true;


} else return false;

}


void compare(String b){

sumT=Integer.parseInt(b);

if ((A1 + A2) == sumT){

Respuesta R = (Respuesta)getAppletContext().getApplet("Respuesta");

R.setRes ("Correcto");

}else {Respuesta R = (Respuesta)getAppletContext().getApplet("Respuesta");

R.setRes ("Incorrecto");

}
```

Appendix 2.

Explanation statement for parents

E-ludic learning for rural areas:
A system for Digital Puebla

Project Number: RO394

We are conducting research on the use of computers in education. We believe that computers can be used to teach complex knowledge and skills like mathematics and the use of computers can produce general understanding about computers themselves.

To examine the role of computers in early childhood education, we are seeking 40 1st-grade children to take part in our research. In our research, all children will be given a 20-minute test of math skills. Then, 20 children will visit the SICOM Regional Centre four times over a two-week period in September. The other 20 children will remain in their school classroom. Both groups of children will be taught basic addition mathematics as part of their regular education. However, the 20 children who visit the SICOM Regional Centre will be taught by using a computer programme and the 20 children who remain in their school classroom will be taught by their teacher. After the math classes, all children will take another 20-minute math skills test.

We seek your kind permission to be involved in this research and would be very grateful for signed approval indicating that you and your child will be a part of this project. Because participation is voluntary, you should not feel obliged to participate and you or your child would be free to stop participating at any time. There is no penalty for not participating. There is no penalty for deciding to stop participating.

If your child participates in this study, their involvement would be monitored at all times by the School and the SICOM centre. If your child does not want to work on the computer system or travel to the SICOM centre, she or he will not be required to do so. Your child's name will be used on the math skills tests only to match the first and last test. After the last test, all names will be removed and the list of participants will be destroyed. In this way, participation will be confidential. No names will be published in relation to this research. We will store the findings of this research at the University for five years. This is a requirement of the university.

If you have any questions or would like to be informed of the aggregate research findings, please contact us. Finally, should you have any complaint concerning the manner in which this research is conducted, please do not hesitate to contact Bond University Research Ethics Committee, quoting the Project Number RO394.

The Complaints Officer
Bond University Human Research Ethics Committee
Ground Floor, Commercial Centre
Bond University, Gold Coast, 4229.
AUSTRALIA
Telephone +61 (7) 5595 4194 Fax +61 (7) 5595 1153
Email: Mignon Kendall mignon_kendall@bond.edu.au

Sincerely,

Luis Carlos Dominguez
ldomingue@student.bond.edu.au

Dr. Jeffrey E. Brand
jbrand@staff.bond.edu.au

Faculty of Humanities & Social Sciences

Bond University, Queensland 4229, Australia. Telephone +61 7 5595 2522. Facsimile: +61 7 5595 2545. Website: www.bond.edu.au ABN:88 010 694 121

Appendix 3.

Consent letter for parents

BOND UNIVERSITY

E-ludic learning for rural areas:
A system for Digital Puebla

Project Number: RO394

I agree to take part in the above Bond University research project. I have read the above Explanatory Statement. I am willing to allow my child to participate in the study.

I understand that results of the first and second maths test will be kept confidential, and that no information that could lead to the identification of my child in this study will be disclosed in any reports on the project, or to any other party than the school and SICOM Regional Centre.

I also understand that my child's participation is voluntary, that I can choose not to participate in part or all of the project, and that I can withdraw freely at any stage of the project.

I agree that the information I provide can be used by other researchers as long as my name and contact information is removed before it is given to them.

Child's Name: ....
(please print)

My Name: ....

My Signature: ....

Date: ....

INSTRUCTIONS: Please return this consent form to your child's school by 1st September 2004.

Faculty of Humanities & Social Sciences

Bond University, Queensland 4229, Australia. Telephone +61 7 5595 2522. Facsimile: +61 7 5595 2545. Website: www.bond.edu.au ABN:88 010 694 121

Appendix 4.

Letter for SICOM's General Director requesting support for the experiment

Lic. Raúl Victoria Iragorri
Director General del SICOM
Presente

Distinguido Lic.
Le escribe de la manera más atenta Luis Carlos Dominguez estudiante Mexicano de Doctorado en Bond Univeristy, Qld, Australia. El motivo de esta atenta carta es pedir su amable autorización para poder realizar el experimento final de mi tesis doctoral en el Centro Regional SICOM de la municipalidad de Libres.
El experimento entra como la parte de demostración de mi tesis doctoral sobre ambientes e-lúdicos de aprendizaje. La hipótesis de mi tesis es que un ambiente e-lúdico de aprendizaje funciona como una alternativa educativa en zonas rurales. La tesis propone un modelo de aprendizaje lúdico en línea como alternativa educativa para zonas rurales. El experimento busca probar que el ambiente específicamente diseñado bajo dicho modelo, opera como sistema de enseñanza para alcanzar automatización en operaciones de suma. Este ambiente está dirigido a niños de primer año de educación primaria.
Para la realización del experimento y en el caso de contar con su apreciable aprobación, las fechas de utilización de las instalaciones informáticas con acceso a Internet del Centro SICOM en la Municipalidad de Libres serían:
Lunes 6 de Septiembre 2004
Miércoles 8 de Septiembre 2004
Viernes 10 de Septiembre 2004
Lunes 13 de Septiembre de 2004
Los días 3 y 14, se aplicarán un pre-test y post-test en la escuela por seleccionar.
Los horarios están por ser confirmados pero sería en horarios de clases. Cada sesión durará 20 minutos (pre-test y post-test incluidos).
Para la realización de este experimento el que suscribe solicitará contar con 40 niños de primer año de alguna escuela estatal en la Municipalidad de Libres y que de preferencia no cuente con acceso a Internet en sus propias instalaciones. 20 niños integrarán el grupo experimental (irán al centro SICOM) y 20 integrarán el grupo control (estarán en la escuela). Entendiendo que hay 10 computadoras con acceso a Internet en el Centro Regional de Libres, y cada sesión será de 20 minutos, estamos hablando de 40 minutos por día durante cuatro días a lo largo de una semana y media requeridos por su servidor para la realización del experimento.
En seguimiento a los requisitos de mi Universidad para la realización de experimentos con menores he elaborado formas de consentimiento de los padres para la participación de sus hijos en el estudio. Estas deberán ser firmadas por cada padre de familia y por el Director de la Escuela seleccionada. Esta información es logística que su servidor ya tiene coordinada, se lo informo para hacer notar que todas las precauciones serán tomadas en el desarrollo de este trabajo. Le comento también que tengo contratado a un asistente de investigación quien cuenta con todo un apoyo logístico en el Estado, como apoyo a este trabajo. Atentamente le pido su autorización para que el asistente de investigación implemente los experimentos en coordinación con el CID y bajo los lineamientos que usted tenga a bien indicar.
Los beneficios de esta investigación van por el lado de la opción de crear sistemas de aprendizaje en línea como complemento educativo para todo tipo de enseñanza y que vayan creando una capacidad e-literaria en nuestros niños y en la población en general. La importancia de ser fluidos en Tecnologías de la Información está documentada en la literatura mundial, no obstante algunos autores indican que quizá no es muy provechosa la inversión en Tecnologías de la Información en zonas rurales. La tesis doctoral busca demostrar todo lo contrario de ahí su importancia y aspectos positivos. El autor de la tesis entiende como zona rural aquella con una población menor a los 40,000 habitantes.

Espero esta información sea suficiente para su atenta determinación más de ser requeridos más datos con todo gusto se los hago llegar de inmediato.
Agradezco su atención a la presente y la consideración a mi investigación la cual estoy pudiendo realizar con el apoyo de CONACYT.
De antemano le ofrezco mi más alta consideración, quedando de usted a sus apreciables órdenes.
Respetuosamente

Luis Carlos Dominguez
(ldomingu@student.bond.edu.au)
Student number: 12635465
Becario Conacyt: 149867
Supervisor: Dr. Jeff Brand
(jbrand@staff:bond.edu.au)

ccp- Lic. Francisco Arellano Posada, Director de Centros Regionales y CID,
ccp- Lic Yunuen Manjarrez, Subdirectora CID.

Appendix 5.

School Principal letter requesting support for the experiment.

THINK
BOND UNIVERSITY

Prof. Miguel Ángel Pérez Iturbide
Director de Escuela "Juan Escutia"
Presente

Distinguido Sr. Director.

Le escribe de la manera más atenta Luis Carlos Dominguez estudiante Mexicano de Doctorado en Bond Univeristy, Qld, Australia y el Dr. Jeffrey Brand supervisor de mi tesis doctoral. El motivo de esta atenta carta es pedir su amable autorización para poder realizar el experimento final de mi tesis doctoral con alumnos del Primer Año de la primaria la cual usted eficazmente dirige.

El experimento entra como la parte de demostración de mi tesis doctoral sobre ambientes e-lúdicos de aprendizaje. La hipótesis de mi tesis es que un ambiente e-lúdico de aprendizaje funciona como una alternativa educativa en zonas regionales. La tesis propone un modelo de aprendizaje lúdico en línea como alternativa educativa para zonas de desarrollo medio marginal. El experimento busca probar que el ambiente específicamente diseñado bajo dicho modelo, opera como sistema de enseñanza para alcanzar automatización en operaciones de suma. Este ambiente está dirigido a niños de primer año de educación primaria.

Para la realización de esta investigación estamos buscando 40 niños de 1er Grado de Primaria. En nuestra investigación a cada uno de los 40 niños se le aplicará un examen de aritmética matemática y de conocimiento de cultura digital de 20 minutos en total. Al día siguiente, 20 de los niños seleccionados al azar asistirán al Centro Regional SICOM cuatro veces durante dos semanas en sesiones de 20 minutos. Los 20 niños que visiten el Centro Regional del Sistema de Información y Comunicación del Estado de Puebla (SICOM) aprenderán conceptos básicos de suma aritmética mediante un programa computacional por Internet diseñado específicamente para tal fin. Los otros 20 niños seguirán con su instrucción regular en la escuela. Al siguiente día de concluir las sesiones se les aplicará nuevamente un examen de habilidad matemática y cultura digital en la escuela.

Para la realización del experimento y en el caso de contar con su apreciable aprobación, las fechas de petición de los niños serán:

Viernes 3 y 14 de Septiembre 2004 aplicación de examen de conocimiento aritmético de adición y cultura digital de 20 minutos de duración.

Para el grupo de acceso a Internet del Centro SICOM

Lunes 6 de Septiembre 2004

Miércoles 8 de Septiembre 2004

Viernes 10 de Septiembre 2004

Lunes 13 de Septiembre de 2004

Los horarios están sujetos a sus instrucciones más nos gustaría hacerlo en horarios de clases. Cada sesión durará 20 minutos (exámenes incluidos).

Faculty of Humanities & Social Sciences

Bond University, Queensland 4229, Australia. Telephone +61 7 5595 2522. Facsimile: +61 7 5595 2545. Website: www.bond.edu.au ABN: 88 010 694 121

THINK BOND UNIVERSITY

En seguimiento a los requisitos de mi Universidad para la realización de experimentos con menores he elaborado formas de consentimiento de los padres para la participación de sus hijos en el estudio. Estas deberán ser firmadas por cada padre de familia cuya participación de su hijo(a) será voluntaria.

Esta investigación es posible realizarla con el apoyo del Sistema de Información y Comunicación del Estado de Puebla mediante el Centro de Información y Desarrollo del SICOM (CID) así como por medio del Centro Regional en Tepeaca.

De la misma manera tengo contratado a un asistente de investigación quien cuenta con todo un apoyo logístico en el Estado, como soporte a este trabajo. Atentamente le pido su autorización para que el asistente de investigación implemente los experimentos en coordinación con el CID y el Centro Regional Tepeaca.

Los beneficios de esta investigación van por el lado de la opción de crear sistemas de aprendizaje en línea como complemento educativo para todo tipo de enseñanza y que vayan creando una capacidad e-literaria en nuestros niños y en la población en general. La importancia de ser fluidos en Tecnologías de la Información está documentada en la literatura mundial. Próximamente con el desarrollo de Internet 2 las posibilidades se incrementaran aun más siendo ésta una base de partida para una posible nueva política de re-orientación en gasto de infraestructura educativa en provecho de los infantes de toda la región en general.

En todo momento podrá estar presente en la investigación tanto el maestro de los niños así como usted si así lo considera pertinente.

Agradezco su atención a la presente y la consideración a mi investigación la cual estoy pudiendo realizar con el apoyo de CONACYT.

De antemano le ofrezco mi más alta consideración, quedando de usted a sus apreciables órdenes.

Respetuosamente

Luis Carlos Dominguez

(ldomingu@student.bond.edu.au)

Student number: 12635465

Becario Conacyt: 149867

Supervisor: Dr. Jeff Brand

(jbrand@staff:bond.edu.au)

Faculty of Humanities & Social Sciences

Bond University, Queensland 4229, Australia. Telephone +61 7 5595 2522. Facsimile: +61 7 5595 2545. Website: www.bond.edu.au ABN: 88 010 694 121

Appendix 6.

SICOM response to my request for support.

SICOM Email to

ldomingu@austarnet.com.au

translation by Marcela Sosa

Spanish:

From	cbarragan <cbarragan@sicom.edu.mx>
Sent	Wednesday, August 11, 2004 9:28 am
To	ldomingu@student.bond.edu.au
Cc	
Bcc	
Subject	Se confirma apoyo solicitado
Subject	Se confirma apoyo solicitado

Sr. Domínguez:

Por instrucciones del Lic. Raúl Victoria Iragorri, Director General del SICOM, me permito informarle que con mucho gusto procederá a girar instrucciones al Lic. Francisco Arellano Posada, Director de Centros Regionales para que le sea proporcionado el apoyo necesario para la realización del experimento final de su tesis doctoral en el Centro Regional SICOM en Tepeaca. Por lo que a través de la Lic. Yunuen Manjarrez Martínez, Subdirectora de Investigación y Proyectos, adscrita a la Dirección de Centros Regionales, se continuará la comunicación con usted para confirmar fechas y demás detalles.

Asimismo, le solicitamos que al final del desarrollo del experimento y ya con los resultados procesados se sirva hacer una presentación de devolución de los mismos al personal involucrado y a los participantes del mismo, así como proporcionar dos copias de su tesis al SICOM (una para el Centro Regional de Tepeaca y otra para el CID).

Estamos a sus órdenes para cualquier duda o aclaración.

Ma. del Consuelo Barragán R.

Secretaría Particular de la

Dirección General

Ma. del Consuelo Barragán R.
Secretaría Particular de la
Dirección General

English:

Mr Domínguez

Following Mr. Raúl Victoria Iragori, SICOM General Director, instructions, I am pleased to inform you that he is happy to indicate Mr Francisco Arellano Posada, Regional Centres Director for SICOM, to provide you with the necessary support for the realization of your doctoral thesis final experiment in the Tepeaca SICOM Regional Centre.

All further details will be dealt with Mrs Yunuen Manjarrez, Head of Research and Projects Unit (CID) for SICOM.

Additionally, we request you to, once the experiment is concluded and the results analysed, please deliver a presentation to all the parties involved, and please provide two copies of your thesis to SICOM (one for the Tepeaca Regional Centre and another for CID.

Please contact us if you have any doubts

Ma. Del Consuelo Barragán R.

Personal assistant of the

General Director

Sincerely yours

Marcela Sosa Romero
5/126 Marine Parade
Southport 4215
Qld
Australia
Email: msosa_dominguez@hotmail.com
Ph. 07- 55 31 01 49

Appendix 7.

Addition questionnaire for pre-test and post-test (original is in Spanish, this is the English translation)

INSTRUCTIONS- Please Write down the result of adding the two numbers left of the blue rectangle. Use your pencils and write the answer inside the blue rectangle. If you do not know the answer please leave the rectangle blank. Thank you and good luck.

A) 1 + 2 =	
B) 2 + 4 =	
C) 4 + 1 =	
D) 3 + 4 =	
E) 2 + 3 =	
F) 4 + 4 =	
G) 1 + 1 =	
H) 2 + 2 =	
I) 3 + 3 =	
J) 5 + 5 =	

Appendix 8.

DIGITAL KNOWLEDGE QUESTIONAIRE- PRE-TEST AND POST-TEST INSTRUCTIONS.

Research assistant please read loud- “good morning, please mark with an X the image you think is the answer to the question I am going to make to you.

Computer knowledge

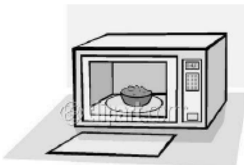
1. Please mark the image that represents a computer
2. Please mark the image that represents a mouse
3. Please mark the image that represents the keyboard
4. Please mark the image that represents the computer’s CPU
5. Please mark the image that represents the computer’s monitor

Digital knowledge

6. Please mark the image that represents a webpage
7. Please tick the blue square that indicates the web page button
8. Please tick the blue box that indicates a text box
9. Please tick the blue box that indicates the key to be push to enter a response
10. Please tick the blue box that indicates the symbol to close the page.

1

`

2

3

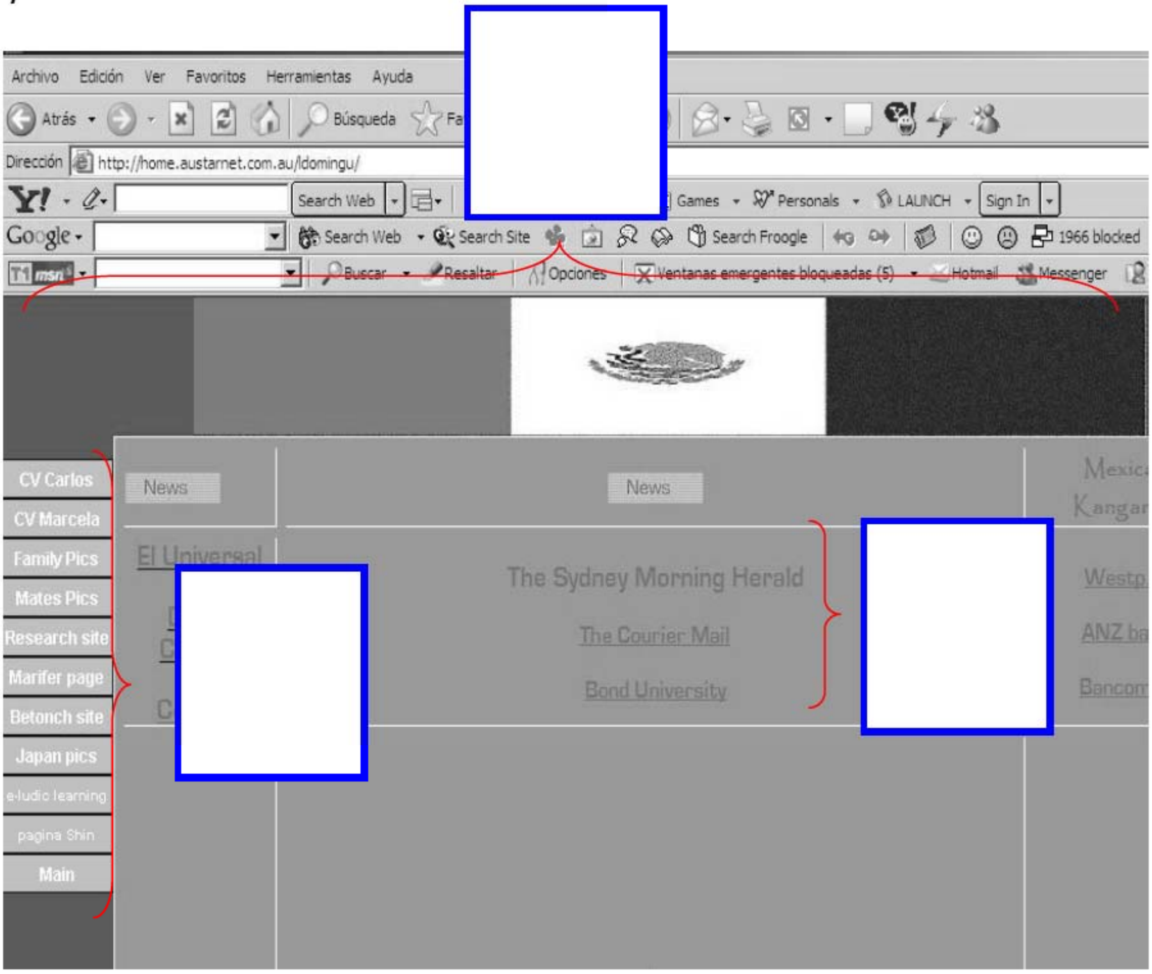
 

4

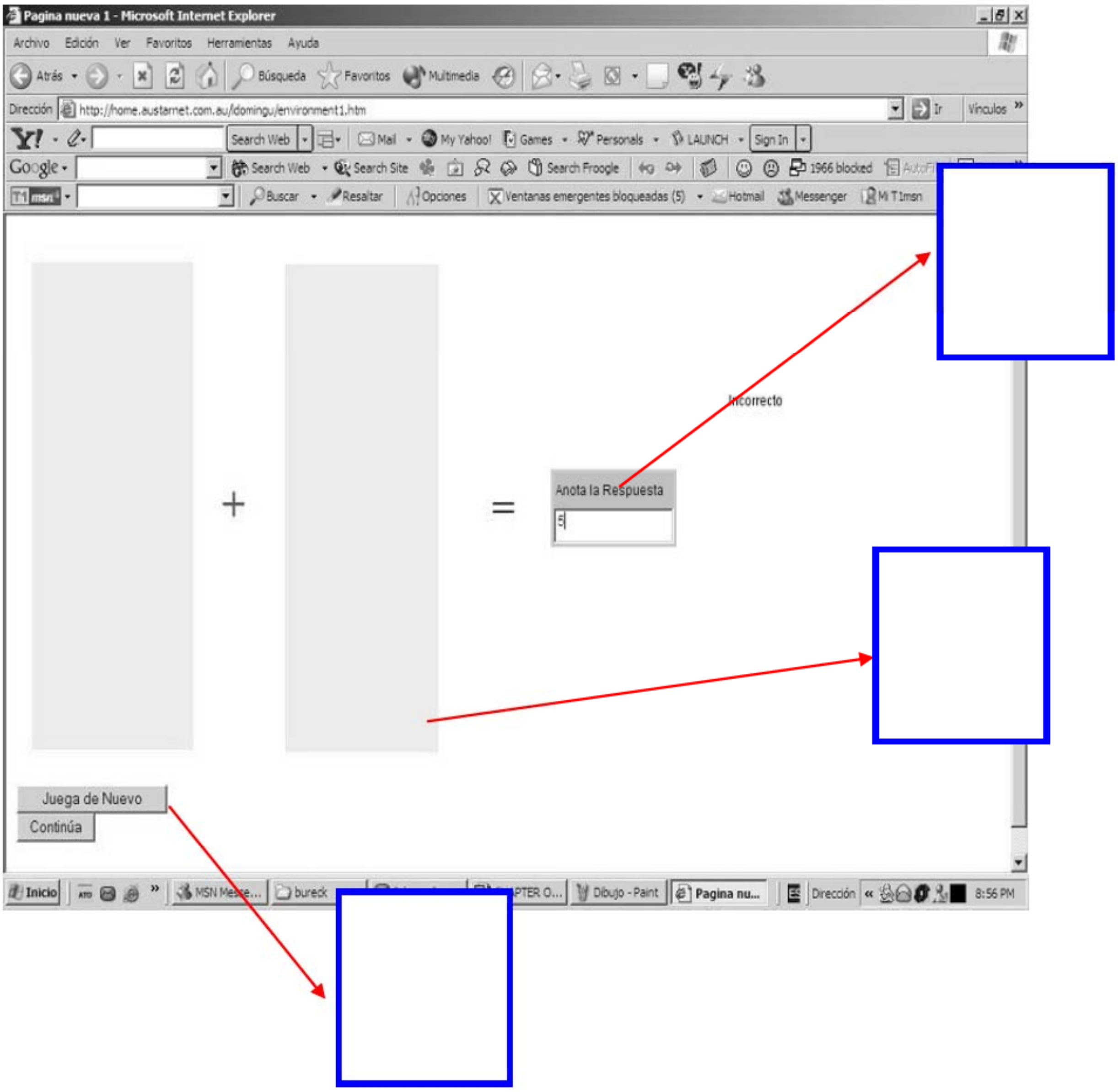
5

6

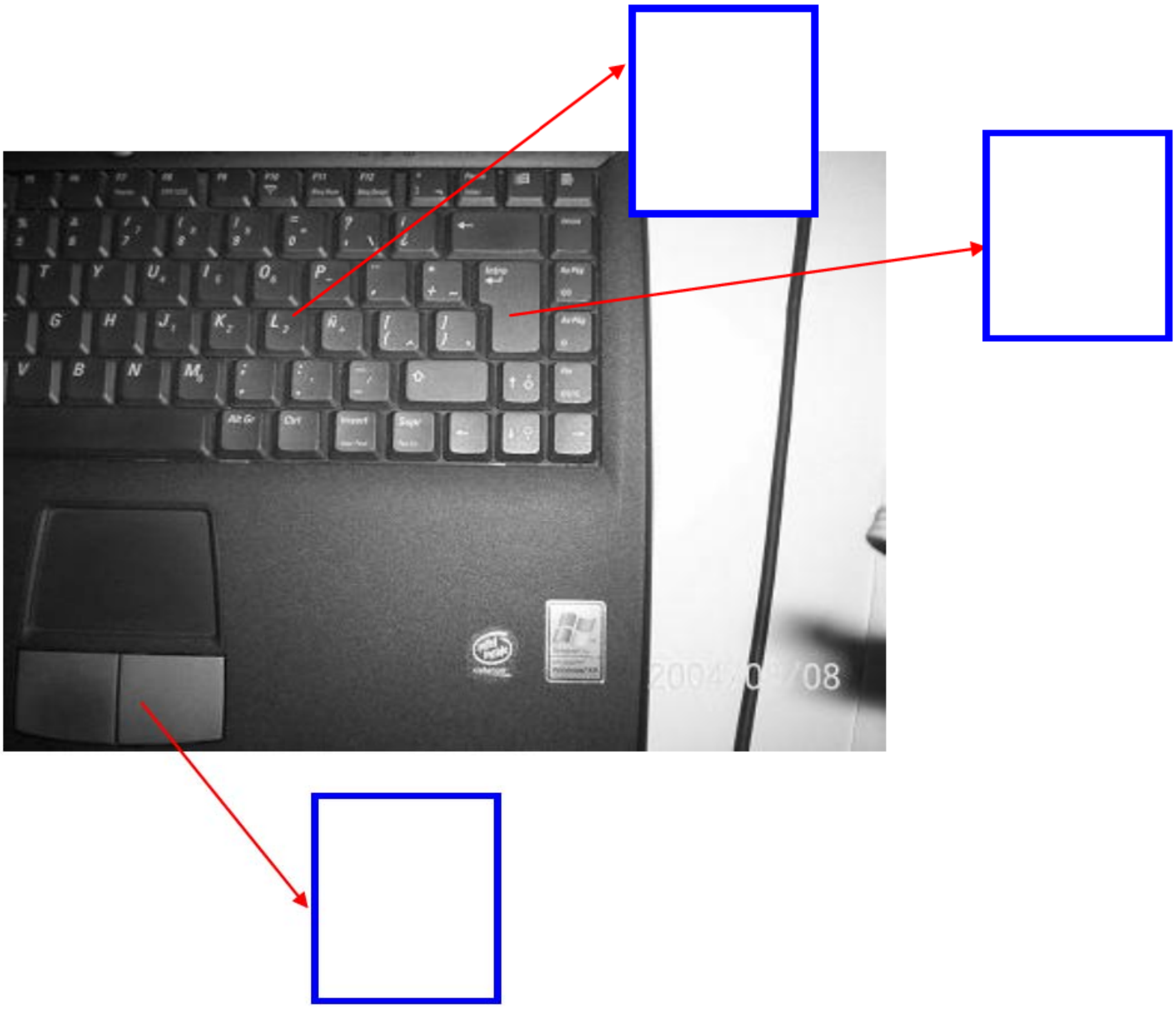
7


Archivo Edición Ver Favoritos Herramientas Ayuda
Atrás
Búsqueda
Dirección http://home.austarnet.com.au/ldomingu/
Search Web
Games
Personals
LAUNCH
Sign In
Search Web
Search Site
Search Froogle
1966 blocked
Buscar
Resaltar
Opciones
Ventanas emergentes bloqueadas (5)
Hotmail
Messenger
CV Carlos
CV Marcela
Family Pics
Mates Pics
Research site
Marifer page
Betonch site
Japan pics
e-ludic learning
pagina Shin
Main
News
News
El Universal
The Sydney Morning Herald
The Courier Mail
Bond University

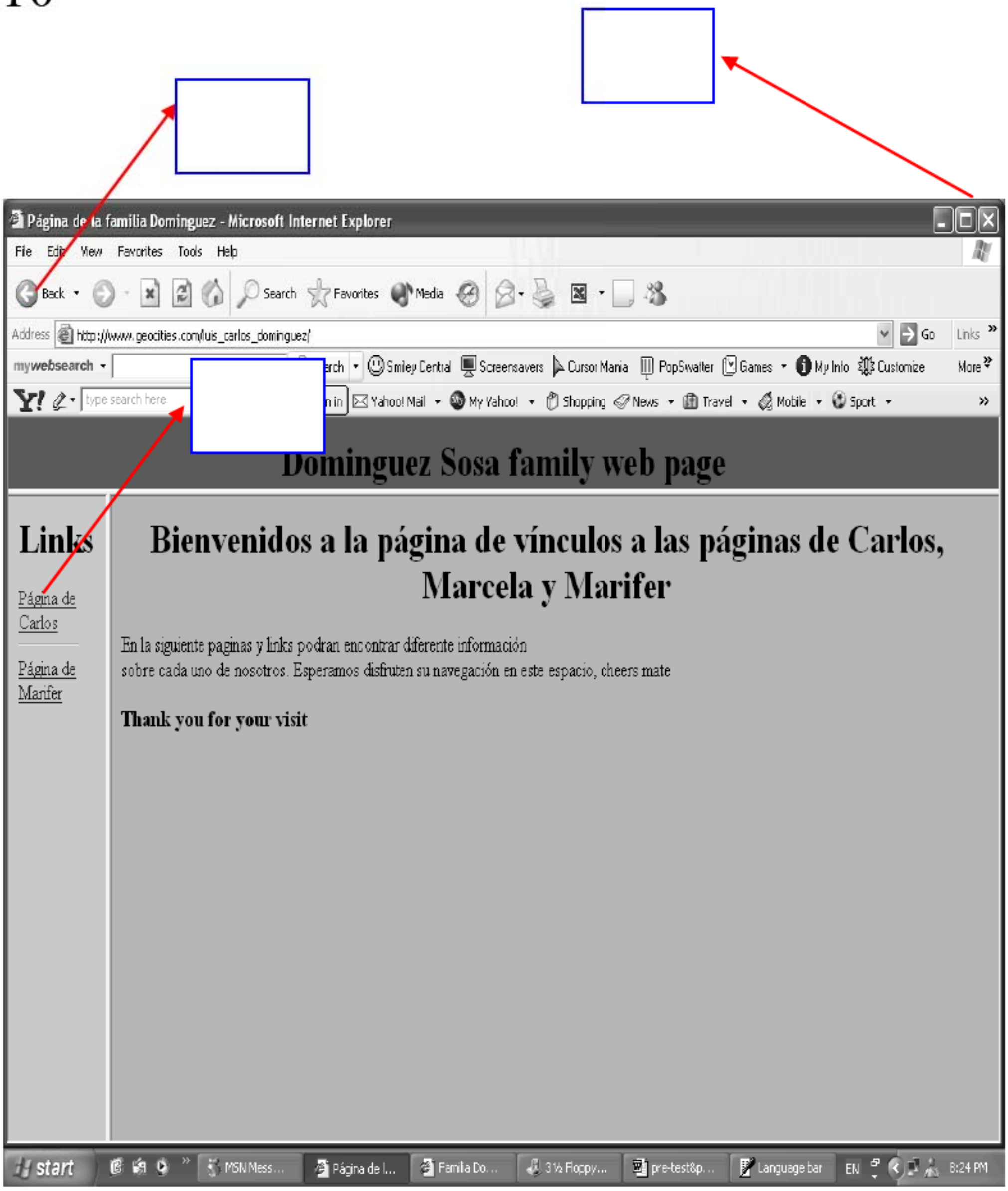
8


Pagina nueva 1 - Microsoft Internet Explorer
Incorrecto
Anota la Respuesta
Juega de Nuevo
Continúa

9



10


Página de la familia Dominguez - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites Media
Address http://www.geocities.com/luis_carlos_dominguez/
Go Links
mywebsearch Smiley Central Screensavers Cursor Mania PopSwatter Games My Info Customize More
Yahoo! Mail My Yahoo! Shopping News Travel Mobile Sport
Dominguez Sosa family web page
Links
Página de Carlos
Página de Marifer
Bienvenidos a la página de vínculos a las páginas de Carlos, Marcela y Marifer
En la siguiente paginas y links podran encontrar diferente información
sobre cada uno de nosotros. Esperamos disfruten su navegación en este espacio, cheers mate
Thank you for your visit
start MSN Mess... Página de l... Familia Do... 3½ Floppy... pre-test&p... Language bar EN 8:24 PM

Appendix 9.

Instructions to be read before the experiment in SICOM Tepeaca regional Centre (English translation).

The instructions must be read loudly and clearly so that the students can participate effectively before starting the e-Ludic learning program.

Research assistant to read aloud:

"Good morning little friends I am Luis Eduardo and today we are going to play a beautiful game in the computer.

Firstly I am going to show the parts of a computer.

This is the monitor (point to the monitor). This is the mouse (hold the mouse). This is the keyboard (hold keyboard) which is made up of keys that represent the alphabet letters so you can write anything that you want (point to keys). Finally, this is the CPU (point to CPU). All these parts work together as one.

Each computer connects to other computers through out the Internet (point network wires). Through the Internet you can see web pages like the one in the monitor now (show web page in monitor) from any place around the world (show environment web page). This web page was developed in Australia for you and it is visible now in this computer thanks to Internet. All the information that you see in the screen travels from Australia to Tepeaca through these wires (hold network wires). This web page has very interesting features so you can learn many interesting things.

As you can see, you can move the mouse and the little arrow moves (move mouse and follow cursor move with finger). This little arrow is called cursor.

Also, you need to write down the address so that you can see the Internet page. Most Internet addresses began with the letter “w” repeated three times like “www”. You need to type in the address inside the browser address box (point address box). Each web page has buttons (show buttons inside environment web page) that take you to other web pages (click on the e-Ludic learning button).

This is the web page of the game we are going to play over the next few days. Here we have two buttons (show buttons to kids). The first button, if you click on it (click button on) teaches you about the addition of two numbers like one and five; you need it to play. Do you hear the voice (when they say yes then click “juega” button). This other button takes you to the game. The green button has the game instructions (click green button on). In short it says that you need to click the clown button and wait for the black dots to show up (click “juega” button on and wait for black dots to show up). Then write the correct answer (click the right answer button on). Play as many times as you like. To continue click the button that looks like a lady (click on the “continua” button). The clown buttons appears again you so can play more. To hear the instructions click the green button on as you did previously (show green button). In this case you have a text box to type in your answer (show text box). First generate the black dots as before and then key in your answer then press and release the enter key (show example). That is how you will send your answer. In the same way, click on the button next to the lady to continue (click on the “continuar” button). Here you have to click on the jugar” button again (click “jugar” button on). Now you have numbers instead of black dots. Like in the first interface (go back to first interface and return quickly) you have to click on the button with the right answer or number (click it). Then continue with the lady button (click “continuar” button on). Now you have arrived at the last web page. Here you see a text box (show text box). Play the same way as you have done before (click “juega” button on) and input your answer in the text box (type in answer and click return key). To play again you have to click the cowboy button on (point button). To see the tutorial about addition once more click on the little notebook button (click “estrategia” button on). Once the session is over click on the little bear button (click “fin” button on). It will lead you to the initial web page.

Ok little friends lets begin playing (sit the children at their computers and start timing them). We start at the count of three and when I say stop, and then you stop playing. I am going to be next to you to answer any question you may have. Start with the notebook button, good luck: one, two, and three go”